IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

NUANCE COMMUNICATIONS, INC., a Delaware corporation, and PHONETIC SYSTEMS LTD., an Israeli corporation,	)	
Plaintiffs,	)	
vs.	)	C. A. No. _____
TELLME NETWORKS, INC., a Delaware corporation,	)	**Jury Trial Demanded**
Defendant.	)	

COMPLAINT FOR PATENT INFRINGEMENT

For its Complaint, plaintiffs Nuance Communications, Inc., a Delaware corporation ("Nuance") and Phonetic Systems Ltd., an Israeli corporation ("Phonetic Systems") (collectively "Plaintiffs") aver as follows:

NATURE OF THE ACTION

1. This is an action for patent infringement. Plaintiffs allege that defendant Tellme Networks, Inc. ("Tellme") infringes Plaintiffs' United States Patent Nos. 5,033,088 and 6,256,630 by making, using, selling, offering for sale and contributing to and/or inducing others to make, use, sell or offer to sell products and services claimed by the patents-in-suit.

PARTIES

2. Nuance is a corporation organized and existing under the laws of the State of Delaware and has its principal place of business in Burlington, Massachusetts. Nuance is engaged in the business of designing, developing and providing speech and imaging products and related services.

3. Phonetic Systems is a corporation organized and existing under the laws of the country of Israel and has a principal place of business at 9 Odem Street in Petach Tikva 49170, Israel. Phonetic Systems is a wholly-owned subsidiary of Nuance.

4. Plaintiffs are informed and believe that defendant Tellme is a corporation organized and existing under the laws of the State of Delaware and has its principal place of business in Mountain View, California.

JURISDICTION AND VENUE

5. This Court has subject matter jurisdiction over this controversy under 28 U.S.C. §§ 1331 and 1338(a).

6. Venue lies within this judicial district pursuant to 28 U.S.C. §§ 1391(b), (c) and 1400(b).

FIRST CLAIM FOR RELIEF
(Infringement of the '088 Patent)

7. Nuance is the owner of record of United States Patent No. 5,033,088 ("the '088 Patent") entitled "Method and Apparatus for Effectively Receiving Voice Input to a Voice Recognition System" with full rights in and to the claims and causes of action involved in this suit. The United States Patent and Trademark Office duly and legally issued the '088 Patent on July 16, 1991. Exhibit A to this complaint is a true and correct copy of the '088 Patent.

8. Defendant has been and is infringing the '088 Patent by making, using, selling and/or offering for sale in the United States, and by contributing to and/or inducing others to make, use, sell and/or offer for sale in the United States, without license from Plaintiffs, products or services that practice the invention claimed in the '088 Patent, including, but not limited to, Tellme's directory assistance and/or call center applications.

9. Plaintiffs are informed and believe, and based thereon aver, that Defendant will continue to infringe, contribute to and/or induce others to infringe, the '088 Patent unless enjoined by this Court.

10. As a direct and proximate result of Defendant's infringement of the '088 Patent, Plaintiffs have been and continue to be damaged in an amount yet to be determined.

11. By reason of the above acts, Defendant has caused and is causing, and unless enjoined and restrained by this Court, will continue to cause Plaintiffs great and irreparable injury to among other things, the good will and business reputation of Plaintiffs and their business relationships, all of which cannot be adequately compensated or measured in money. Plaintiffs have no adequate remedy at law. Plaintiffs are entitled to injunctive relief enjoining and restraining Defendant, its officers, agents, servants, and employees, and all persons acting in concert with Defendant from further infringement of the '088 Patent.

12. Plaintiffs are informed and believe, and based thereon aver, that Defendant's infringement of the '088 Patent is, has been and continues to be committed with full knowledge of Plaintiffs' rights under the '088 Patent, and in willful, wanton and deliberate disregard thereof, rendering this an exceptional case under 35 U.S.C. §285.

SECOND CLAIM FOR RELIEF
(Infringement of the '630 Patent)

13. Phonetic Systems is the owner of record of United States Patent No. 6,256,630 ("the '630 Patent") entitled "Word-Containing Database Accessing System for Responding to Ambiguous Queries, Including a Dictionary of Database Words, a Dictionary Searcher and a Database Searcher" with full rights in and to the claims and causes of action involved in this suit.

The United States Patent and Trademark Office duly and legally issued the '630 Patent on July 3, 2001. Exhibit B to this complaint is a true and correct copy of the '630 Patent.

14. Defendant has been and is infringing the '630 Patent by making, using, selling and/or offering for sale in the United States, and by contributing to and/or inducing others to make, use, sell and/or offer for sale in the United States, without license from Plaintiffs, products or services that practice the invention claimed in the '630 Patent, including, but not limited to, Tellme's directory assistance and/or call center applications.

15. Plaintiffs are informed and believe, and based thereon aver, that Defendant will continue to infringe, contribute to and/or induce others to infringe, the '630 Patent unless enjoined by this Court.

16. As a direct and proximate result of Defendant's infringement of the '630 Patent, Plaintiffs have been and continue to be damaged in an amount yet to be determined.

17. By reason of the above acts, Defendant has caused and is causing, and unless enjoined and restrained by this Court, will continue to cause Plaintiffs great and irreparable injury to among other things, the good will and business reputation of Plaintiffs and their business relationships, all of which cannot be adequately compensated or measured in money. Plaintiffs have no adequate remedy at law. Plaintiffs are entitled to injunctive relief enjoining and restraining Defendant, its officers, agents, servants, and employees, and all persons acting in concert with Defendant from further infringement of the '630 Patent.

18. Plaintiffs are informed and believe, and based thereon aver, that Defendant's infringement of the '630 Patent is, has been and continues to be committed with full knowledge of Plaintiffs' rights under the '630 Patent, and in willful, wanton and deliberate disregard thereof, rendering this an exceptional case under 35 U.S.C. §285.

DEMAND FOR JURY TRIAL

Plaintiffs Nuance Communications, Inc. and Phonetic Systems Ltd. hereby demand trial by jury of all issues so triable under the law.

PRAYER FOR RELIEF

WHEREFORE, plaintiffs Nuance Communications, Inc. and Phonetic Systems Ltd. pray for judgment against Defendant as follows:

(1) Preliminarily and permanently enjoining Defendant, its officers, agents, servants, and employees, and all persons acting in concert with Defendant, from infringing and contributing to and/or inducing others to infringe U.S. Patent Nos. 5,033,088 and 6,256,630;

(2) Awarding Plaintiffs damages based on Defendant's infringement of U.S. Patent Nos. 5,033,088 and 6,256,630, and trebling same by reason of the willful, wanton and deliberate nature of such infringement;

(3) Assessing prejudgment interest on damages;

(4) Declaring that this is an exceptional case under 35 U.S.C. § 285 and awarding Plaintiffs their attorney's fees and costs in this action; and

(5) Awarding such other and further relief as the Court deems just and equitable.

OF COUNSEL:
Mark A. Samuels
Mark C. Scarsi
Jeffrey A. Fehervari
O'Melveny & Myers LLP
400 South Hope Street
Los Angeles, California 90071-2899
Telephone: (213) 430-6000
Facsimile: (213) 430-6407

Dated: February 17, 2006

Frederick L. Cottrell, III (#2555)
cottrell@rlf.com
Gregory E. Stuhlman (#4765)
stuhlman@rlf.com
Richards, Layton & Finger, P.A.
One Rodney Square
P.O. Box 551
Wilmington, Delaware 19899
(302) 651-7700

Attorneys for Plaintiffs Nuance Communications, Inc. and Phonetic Systems Ltd.

EXHIBIT A

United States Patent [19]

Shipman

[11] **Patent Number: 5,033,088**

[45] **Date of Patent: Jul. 16, 1991**

[54] **METHOD AND APPARATUS FOR EFFECTIVELY RECEIVING VOICE INPUT TO A VOICE RECOGNITION SYSTEM**

[75] Inventor: **David W. Shipman, Cambridge, Mass.**

[73] Assignee: **Voice Processing Corp., Washington, D.C.**

[21] Appl. No.: **453,108**

[22] Filed: **Dec. 21, 1989**

Related U.S. Application Data

[63] Continuation of Ser. No. 202,506, Jun. 6, 1988, abandoned.

[51] **Int. Cl.**[5] **G10L 5/00; H04M 3/50**

[52] **U.S. Cl.** **381/43; 379/88**

[58] **Field of Search** 364/513.5; 381/41–43; 379/88, 89

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,462,080	7/1984	Johnstone et al.	364/513.5
4,475,189	10/1984	Herr et al.	379/88
4,593,157	6/1986	Usdan	379/89
4,618,984	10/1986	Das et al.	381/43
4,651,289	3/1987	Maeda et al.	364/513.5
4,827,500	5/1989	Binkerd et al.	379/88

OTHER PUBLICATIONS

Jones, "Building Block Circuits Simplify Integration on Voice-Input Systems", Computer Technology Review; Los Angeles, CA, U.S.A., Jan. 3, 1983; No. 1, pp. 63–67.

Primary Examiner—Gary V. Harkcom
Assistant Examiner—David D. Knepper
Attorney, Agent, or Firm—Fleit, Jacobson, Cohn, Price, Holman & Stern

[57] **ABSTRACT**

Processing voice information is performed to complete a task with minimal human intervention. Information received by the automated system from the caller is fed into a speech recognition system, which attempts to recognize the information. The caller's input also is recorded by a recording device. The task is completed if the information is reliably recognized. If the information is not reliably recognized, the speech recognition system optionally requests that the information be repeated. The repeated information is received by the system, and the speech recognition system again attempts to identify the information. The task is completed if the repeated information is reliably recognized. If the repeated information is again not reliably recognized by the speech recognition system, and usually without the caller knowing, the spoken information is transmitted to a human attendant who attempts to identify the information by a playback of the recorded information and possibly a visual display of the speech recognition system's proposed solution to what the caller stated. If the caller's information is recognized, the human attendant then inputs the information so that the system can complete the task. If the human attendant is also unable to recognize the information, the attendant directly requests further information from the caller until the desired information is received.

5 Claims, 2 Drawing Sheets

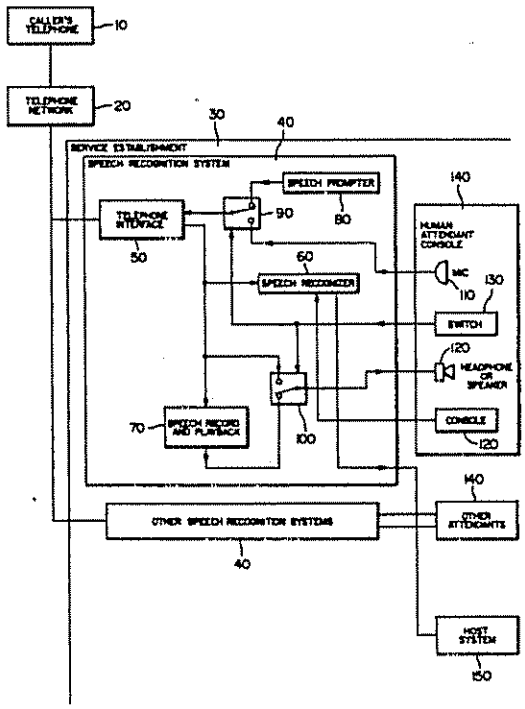


FIG. 1

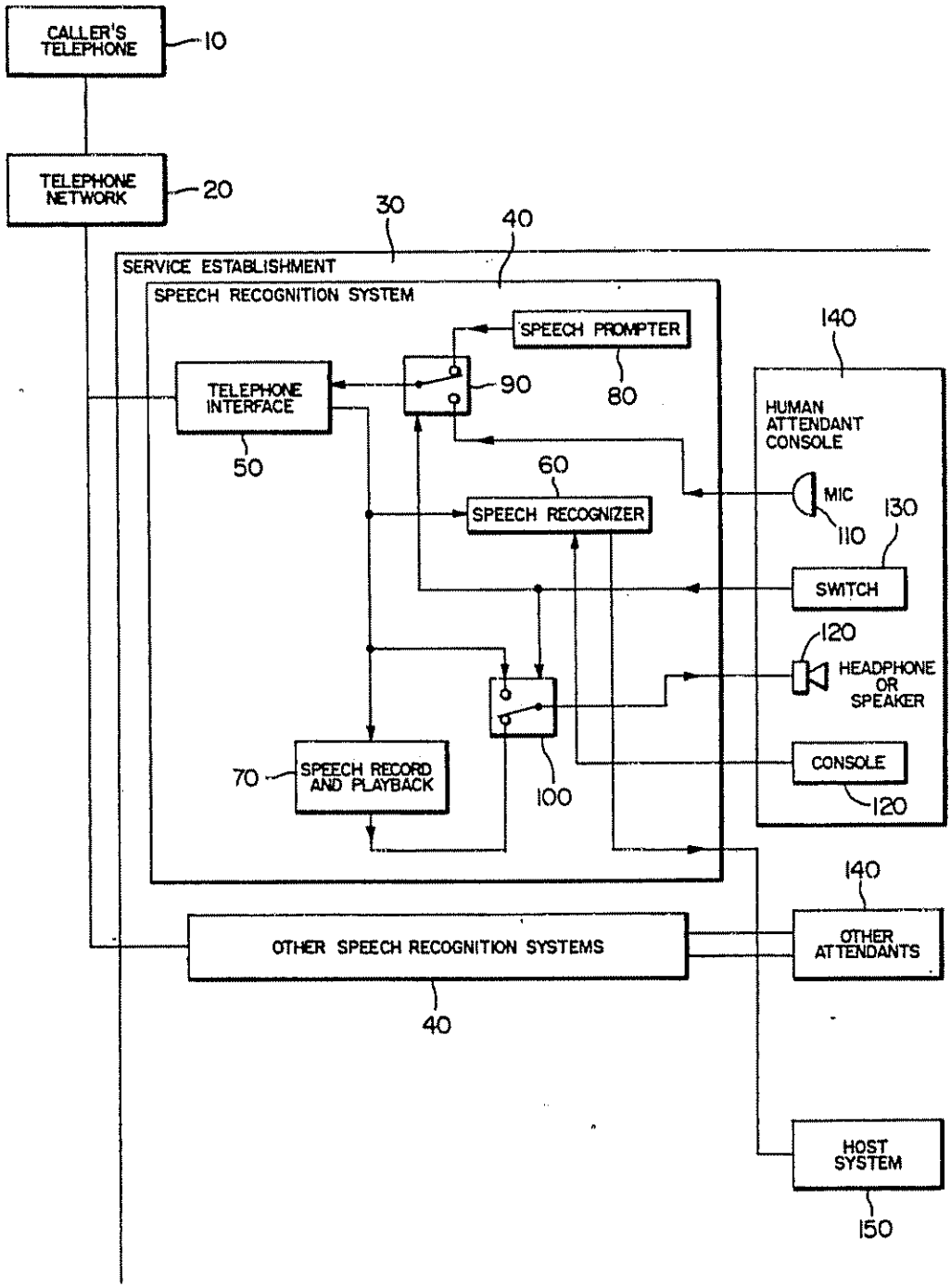
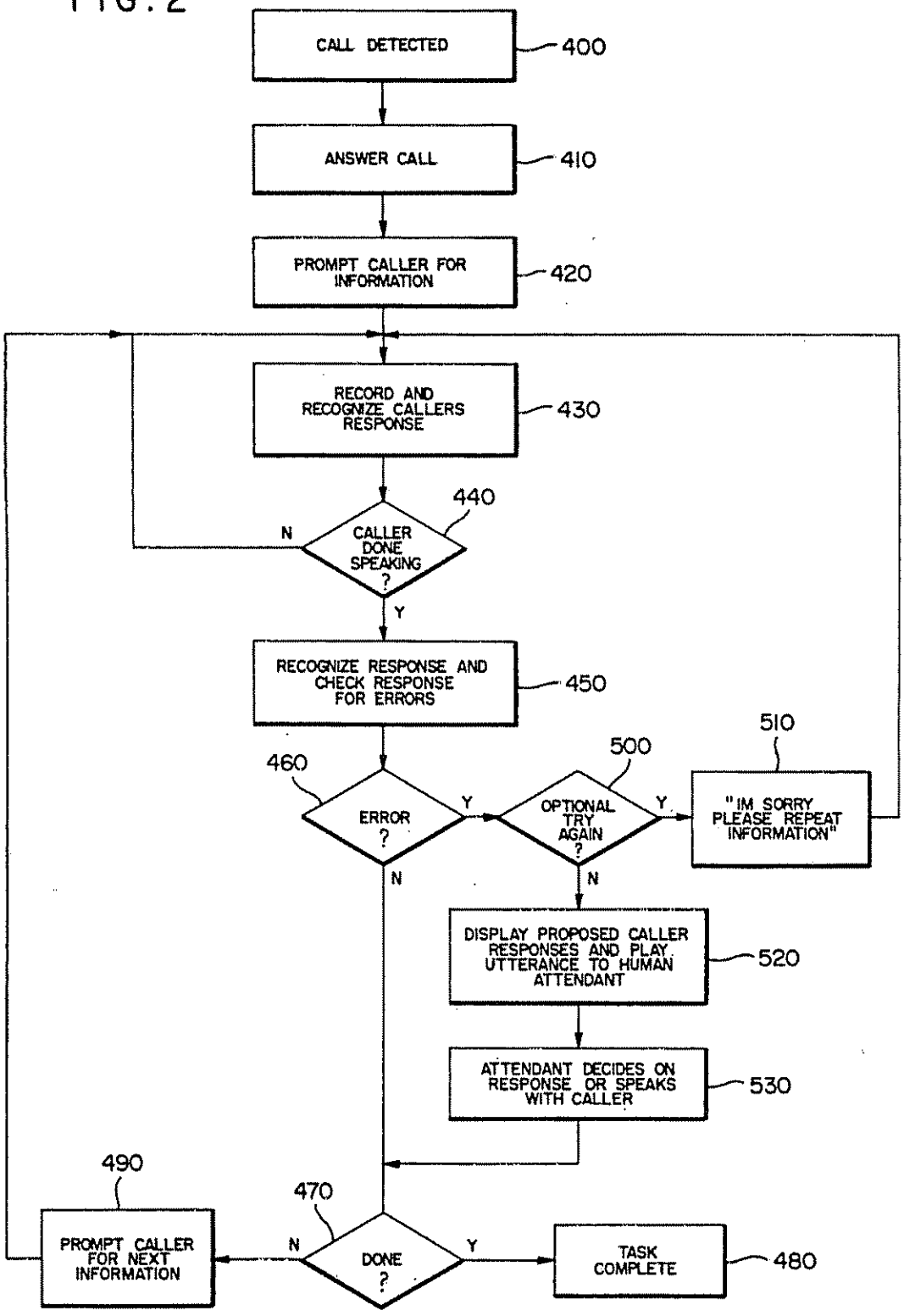

CALLER'S TELEPHONE
10
TELEPHONE NETWORK
20
30
40
SERVICE ESTABLISHMENT
SPEECH RECOGNITION SYSTEM
SPEECH PROMPTER
80
140
TELEPHONE INTERFACE
50
90
HUMAN ATTENDANT CONSOLE
60
SPEECH RECOGNIZER
MIC
110
130
SWITCH
120
HEADPHONE OR SPEAKER
70
SPEECH RECORD AND PLAYBACK
100
CONSOLE
120
140
OTHER SPEECH RECOGNITION SYSTEMS
40
OTHER ATTENDANTS
HOST SYSTEM
150

FIG. 2


CALL DETECTED
400
ANSWER CALL
410
PROMPT CALLER FOR INFORMATION
420
RECORD AND RECOGNIZE CALLERS RESPONSE
430
440
CALLER DONE SPEAKING ?
N
Y
RECOGNIZE RESPONSE AND CHECK RESPONSE FOR ERRORS
450
460
ERROR ?
Y
500
OPTIONAL TRY AGAIN ?
Y
510
"IM SORRY PLEASE REPEAT INFORMATION"
N
N
DISPLAY PROPOSED CALLER RESPONSES AND PLAY UTTERANCE TO HUMAN ATTENDANT
520
ATTENDANT DECIDES ON RESPONSE OR SPEAKS WITH CALLER
530
490
470
PROMPT CALLER FOR NEXT INFORMATION
N
DONE ?
Y
TASK COMPLETE
480

METHOD AND APPARATUS FOR EFFECTIVELY RECEIVING VOICE INPUT TO A VOICE RECOGNITION SYSTEM

This application is a continuation of application Ser. No. 07/202,506, filed Jun. 6, 1988, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to systems in which a speech recognition device is utilized to receive spoken information from an incoming caller, process the information, and complete a predetermined task.

The use of automated speech recognition devices to process spoken information received over telephone lines is well known and is becoming increasingly popular. It should be clear that if such an automated speech recognition device is utilized, it is very important that the speaker communicates accurate information to the system, and does so with maximum machine assistance to the speaker. And, if the speech recognition device is unable to satisfactorily identify information presented by the caller, it is important that the caller be prompted as few times as possible to repeat the questionable information. At the same time, it is essential that accurate information be received and processed by the device.

Accordingly, it is an object of this invention to provide an automatic speech recognition system for receiving and processing voice-communicated information from a human in an efficient and pleasing manner.

Other objects and advantages of the invention will become apparent from the following detailed description when considered in conjunction with the accompanying drawings.

SUMMARY OF THE INVENTION

According to the invention, there is provided a method and apparatus for processing spoken information so that an automated system is able to complete a task with minimal contact with a caller. This method, and its associated apparatus, comprises receiving verbal information from the caller, attempting to recognize the information and completing the task if the information is recognized. All spoken information from the caller is recorded by the recognition system.

If the spoken information is not recognized by the automated speech recognition system, then the system automatically and without the knowledge of the caller switches to a mode that includes the intervention of a human attendant. Even then, the entire transaction generally proceeds without the caller ever knowing that a human has intervened.

The human attendant could receive two types of information from the automated system. The first is a screen display showing the recognition system's possible "solutions" for the caller's spoken information. The second is the recorded utterance that is played for the attendant over an audio playback device.

The human attendant could therefore view the display of the most likely identity (or identities) of the repeated information and could also listen to the verbal input to determine whether or not the input is recognizable. If the recorded information is recognizable, the attendant inputs the recognized information (via a keyboard or other input device) into the system so that the system may complete the given task. The screen display is designed to facilitate the input of information by the attendant (as by permitting the input of a full word by means of single character). If, on the other hand, the recorded information cannot be recognized by the human attendant, the attendant may cut in and communicate with the caller directly in order to gain an understanding of the previously unrecognized information; this would be the only circumstance under which the caller will know that an attendant has intervened. The attendant then inputs the proper information into the system, which then completes the given task.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the voice recognition system of the present invention; and

FIG. 2 is flow diagram of the voice recognition system depicted in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 schematically illustrates at 5 the elements which comprise the automated speech recognition apparatus of the invention. FIG. 1 shows a caller's telephone 10 connected by a telephone line through the telephone network 20 to a speech recognition system 40 at a given service establishment 30. Within the automated speech recognition system is a recorder or other audio recording device 70 such as a disc drive or electronic memory. Recorder 70 can provide recorded voice information to a human attendant at console 140 via a headphone or speaker 120. Depending on the ability of the automated speech recognition system to identify information provided by the caller, either the speech recognition system 40 or the human attendant at console 140 will determine what information was spoken by the caller.

The speech recognition apparatus illustrated in FIG. 1 operates generally as follows. The caller is prompted for information by a known speech prompter 80, and the caller's spoken words are processed by a known speech recognizer 60. At the same time, the caller's response is recorded by recording and playback device 70. If the speech recognizer 60 recognizes the caller's response, it will provide a signal via known means and in a known manner to the host system 150 to complete the task.

Several methods can be used by the recognition system to determine if the information spoken by the caller was correctly recognized. They include the following, as examples:

(1) The recognition device calculates and assigns a probability of correctness to its estimate of information spoken by the caller.

(2) If the utterance is a digit string, a check-sum of digits is computed.

(3) If the recognition device proposes a word that does not conform to the expected caller responses, an error assumption is made.

In the event the speech recognition system 40 fails to recognize the caller's response, an error is detected, the task is not completed, and the caller's recorded response and the recognizer's proposed response or responses are presented to the human attendant at console 140 via headphone or speaker 120 and operator's console 160. Based upon the information presented, the human attendant at console 140 can either complete the task, if the request is understood, or alternatively, switching means 90 and 100 can be utilized so that the human attendant can speak with and listen to the caller via microphone 110 and headphone or speaker 120, if the recorded re-

sponse is not understood, in order to ascertain precisely what was the caller's response.

Referring now to FIG. 2, the process by which the automated system described above deals with an incoming call is illustrated step by step. When an incoming telephone call is detected by the automated system, the call is automatically answered by telephone interface 50 at step 410. The caller is prompted at step 420 by the automated system to provide information which the system 40 will attempt to recognize. The caller then speaks, thereby providing the system with verbal information. The system receives and records the verbal information at step 430 and waits for the caller to finish speaking at step 440. The speech recognizer 60 recognizes the speech and checks for errors at step 450. If the speech recognizer 60 determines it has correctly recognized the caller's verbal request, it then is able to signal the host system 150 to complete the task the caller desires. In the event that the speech recognizer 60 determines it has not correctly recognized the verbal request made by the caller, the caller is optionally prompted once again at step 500 to repeat the information originally provided to the system. The repeated information is again received and recorded at step 430 by the system.

If, at step 450, the speech recognizer 60 determines that it correctly recognizes the verbal request based upon the information repeated by the caller, the speech recognition system 40 will complete the task requested. In the event that the speech recognizer 60 determines it has again failed to recognize the verbal request, there is now no need to ask for an additional repeated request from the caller. Instead the information which was previously recorded by speech record and playback device 70 is repeated at step 520 over headphone or speaker 120 so that the human attendant at console 140 is able to hear the repeated and recorded information. The recognizer 60 also displays on operator's console 160 proposed solutions to what the caller said.

If, at step 530, the human attendant 140 is able to determine from hearing the recorded, repeated information what was said by the caller, the human attendant enters or corrects the information at the console 160. The attendant, for example, may use a keyboard to input information into console 160. The information is transmitted from console 160 to speech recognizer 60, which then completes the task. Alternatively, in the event that the human attendant is unable at step 530 to recognize the repeated information, he or she may cut in on the line with the caller and assist the caller by asking for further information.

Most caller phone calls will be serviced by the speech recognition system 40 and host system 150 without the need of a human attendant. This allows one attendant to service many speech recognizers or, alternatively, the attendant could be occupied with other activities when not servicing speech recognizer requests for attendant intervention.

Attendants can be connected to any recognition system via known network or switching means allowing any recognizer with a need for attendant intervention to be connected to any free attendant for resolution of a recognition task.

The foregoing is considered as illustrative of the invention. Since numerous modifications and changes may occur to those skilled in the art, it is to be understood that the invention is not to be limited to the exact construction and operation shown and described.

What is claimed:

1. A method of processing verbal information received by an automated voice recognition system from a customer and completing a task on the basis of the information received, the method comprising the steps of:

prompting a verbal response from a human customer as an input source;

receiving information in the verbal response from the input source generated by the human customer, said information corresponding to a desired task to be completed;

recording the verbal response;

attempting to recognize said information through automation;

determining by automation if the information was reliably recognized;

transmitting the recorded verbal response of the human customer to a human attendant other than the human customer if it is determined that said information was not reliably recognized;

inputting correct information by the human attendant so as to enable the completion of the desired task through automation; and

completing the desired task with the automatically recognized information if it is determined that said information was reliably recognized or with the human attendant inputted information if it is determined that said information was not reliably recognized.

2. A method as defined by claim 1 and further comprising the step of:

prompting a repeated verbal response from the human input source.

3. An apparatus for processing verbal information from a customer to complete a task comprising:

means for prompting a verbal response from a human customer as an input sources;

a speech recognizer including means for recognizing information in the verbal response and means for determining if the information was reliably recognized;

recording means for recording the verbal response;

means for enabling information to be manually input into the speech recognition system; and

means for completing the task automatically if the information was reliably recognized by said speech recognizer, said means for completing the task completes the task with the recognized information, and including means for manually completing the task if the information was not reliably recognized by said speech recognizer, said means for completing the task completes the task with the information inputted by a human attendant other than the human customer after reviewing the recorded verbal response.

4. A method of processing verbal information received by an automated voice recognition system to complete a task, said method comprising the steps of:

prompting a verbal response from a human customer source, said verbal response including information for carrying out a specific task;

receiving said information in said verbal response from said human customer source;

recording said verbal response;

attempting to recognize said information via said voice recognition system;

determining if said information is either recognizable or unrecognizable by said voice recognition system; and

carrying out said specific task directly if said information is recognizable on the one hand, or on the other hand, transmitting said recorded verbal response to a human attendant other than the human customer if said information is unrecognizable, to allow said human attendant to provide the information corresponding to said specific task to enable completion of said specific task.

5. An apparatus for processing verbal information for completing a task comprising:

means for prompting a verbal response from a human customer as an input source;

speech recognizing means for attempting to recognize information in said verbal response and including means for determining if said information is recognizable or unrecognizable;

recording means for recording the verbal response;

means for completing said task;

means for enabling said information to be manually input by a human attendant other than the human customer to trigger said means for completing the task to complete the task if said information is unrecognizable, on the one hand, or on the other hand, for triggering directly said means for completing the task to complete the task if said information is recognizable.

* * * * *

EXHIBIT B

US006256630B1

(12) **United States Patent**
Gilai et al.

(10) **Patent No.: US 6,256,630 B1**
(45) **Date of Patent: Jul. 3, 2001**

(54) **WORD-CONTAINING DATABASE ACCESSING SYSTEM FOR RESPONDING TO AMBIGUOUS QUERIES, INCLUDING A DICTIONARY OF DATABASE WORDS, A DICTIONARY SEARCHER AND A DATABASE SEARCHER**

(75) Inventors: **Atzmon Gilai**, Holon; **Hezi Resnekov**, Ra'anana, both of (IL)

(73) Assignee: **Phonetic Systems Ltd.**, Holon (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days

(21) Appl. No.: **09/335,456**

(22) Filed: **Jun. 17, 1999**

Related U.S. Application Data

(63) Continuation of application No. 08/749,374, filed on Nov. 20, 1996, now Pat. No. 6,018,736, which is a continuation of application No. 08/317,040, filed on Oct. 3, 1994, now abandoned.

(51) **Int. Cl.**[7] **G06F 17/21**

(52) **U.S. Cl.** **707/6**; 707/532; 707/533; 707/5; 704/239; 704/240; 704/251

(58) **Field of Search** 707/5, 533, 6, 707/532; 704/255, 239, 240, 251

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,131,045	*	7/1992	Roth	704/237
5,218,536	*	6/1993	McWherter	707/533
5,297,039	*	3/1994	Kanaegami et al.	707/5
5,333,317	*	7/1994	Dann	707/5
5,418,951	*	5/1995	Damashek	707/5
5,457,770	*	10/1995	Miyazawa	704/255
5,479,489	*	12/1995	O'Brien	379/67
5,621,857	*	4/1997	Cole et al.	704/232
5,623,578	*	4/1997	Mikkilineni	704/255
5,638,425	*	6/1997	Meador, III et al.	379/88
5,873,056	*	2/1999	Liddy et al.	704/9

* cited by examiner

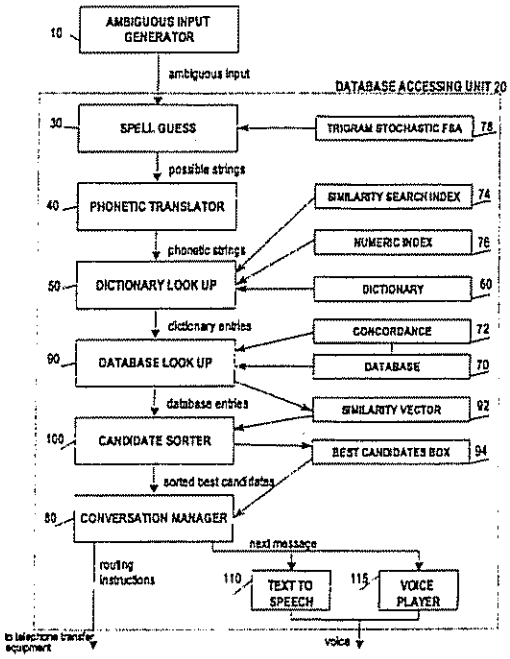
Primary Examiner—Jean R. Homere
(74) *Attorney, Agent, or Firm*—David L. Davis

(57) **ABSTRACT**

A database accessing system for processing a request to access a database including a multiplicity of entries, each entry including at least one word, the request including a sequence of representations of possibly erroneous user inputs, the system including a similar word finder operative, for at least one interpretation of each representation, to find at least one database word which is at least similar to that interpretation, and a database entry evaluator operative, for each database word found by the similar word finder, to assign similarity values for relevant entries in the database, said values representing the degree of similarity between each database entry and the request.

7 Claims, 12 Drawing Sheets

Microfiche Appendix Included
(8 Microfiche, 782 Pages)



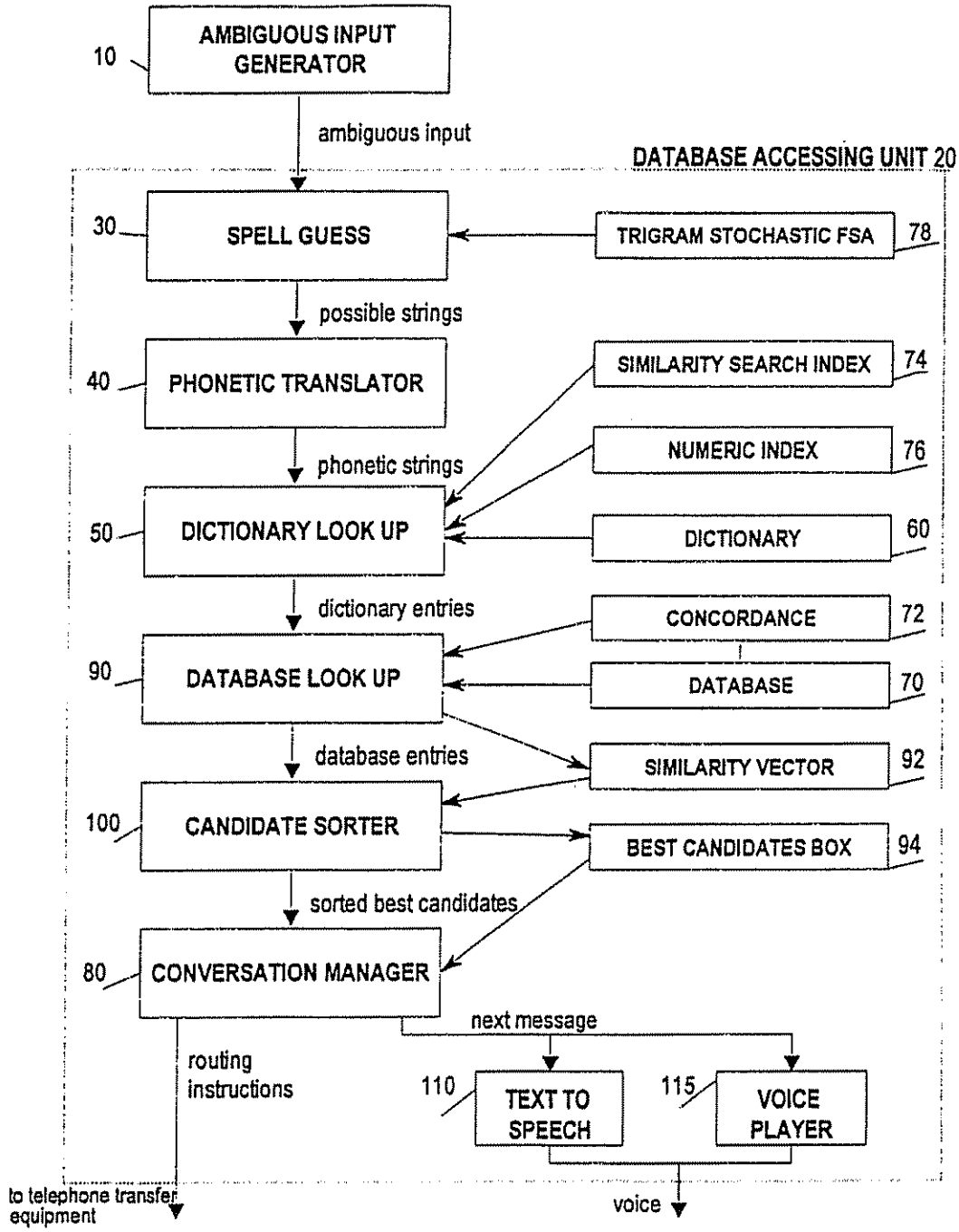

10
AMBIGUOUS INPUT GENERATOR
ambiguous input
DATABASE ACCESSING UNIT 20
30
SPELL GUESS
TRIGRAM STOCHASTIC FSA
78
possible strings
40
PHONETIC TRANSLATOR
SIMILARITY SEARCH INDEX
74
NUMERIC INDEX
76
phonetic strings
50
DICTIONARY LOOK UP
DICTIONARY
60
dictionary entries
CONCORDANCE
72
90
DATABASE LOOK UP
DATABASE
70
database entries
SIMILARITY VECTOR
92
100
CANDIDATE SORTER
BEST CANDIDATES BOX
94
sorted best candidates
80
CONVERSATION MANAGER
next message
routing instructions
110
TEXT TO SPEECH
115
VOICE PLAYER
to telephone transfer equipment
voice

Fig. 1

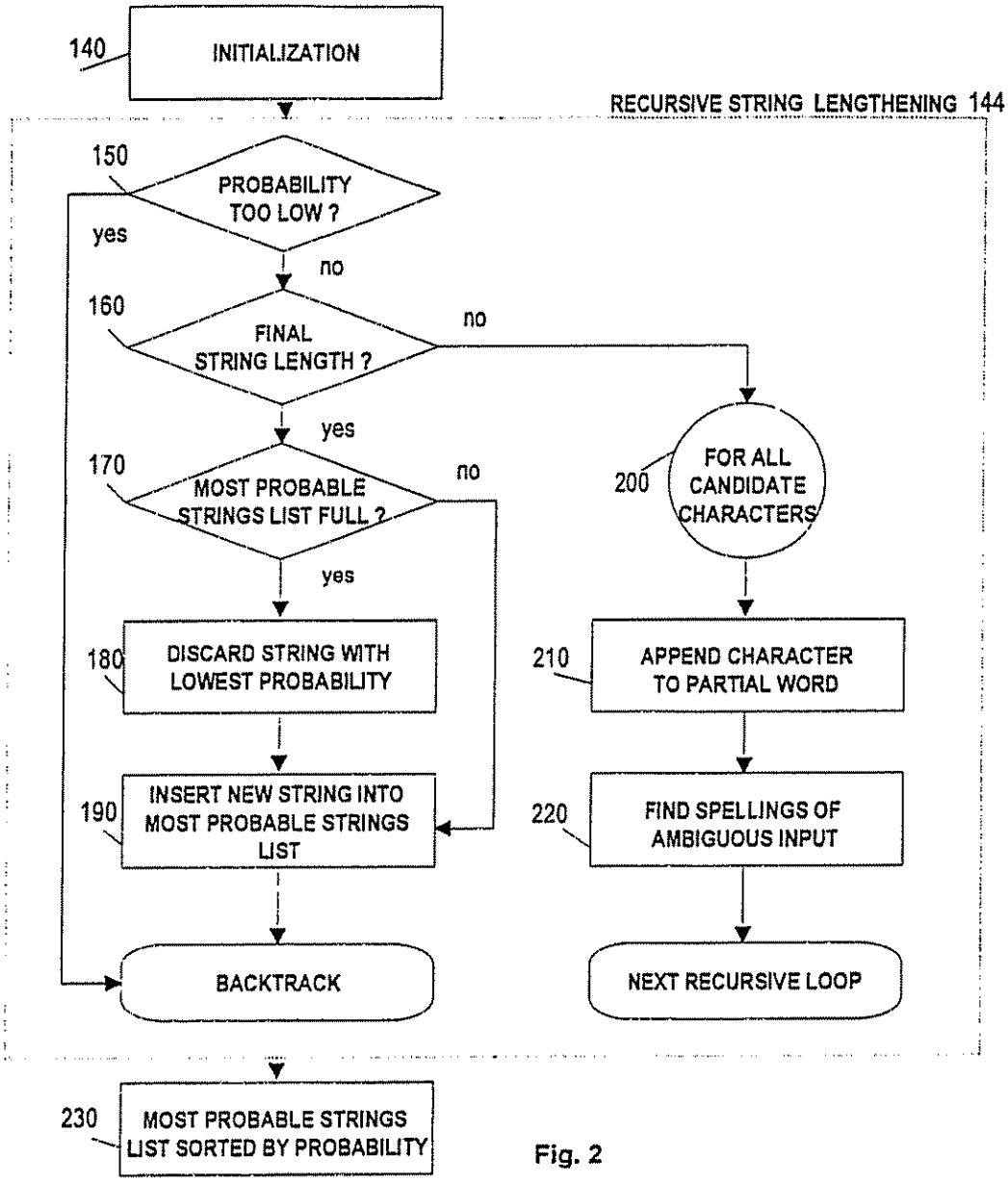

140
INITIALIZATION
RECURSIVE STRING LENGTHENING 144
150
PROBABILITY TOO LOW ?
yes
no
160
FINAL STRING LENGTH ?
no
yes
170
MOST PROBABLE STRINGS LIST FULL ?
no
yes
200
FOR ALL CANDIDATE CHARACTERS
180
DISCARD STRING WITH LOWEST PROBABILITY
210
APPEND CHARACTER TO PARTIAL WORD
190
INSERT NEW STRING INTO MOST PROBABLE STRINGS LIST
220
FIND SPELLINGS OF AMBIGUOUS INPUT
BACKTRACK
NEXT RECURSIVE LOOP
230
MOST PROBABLE STRINGS LIST SORTED BY PROBABILITY

Fig. 2

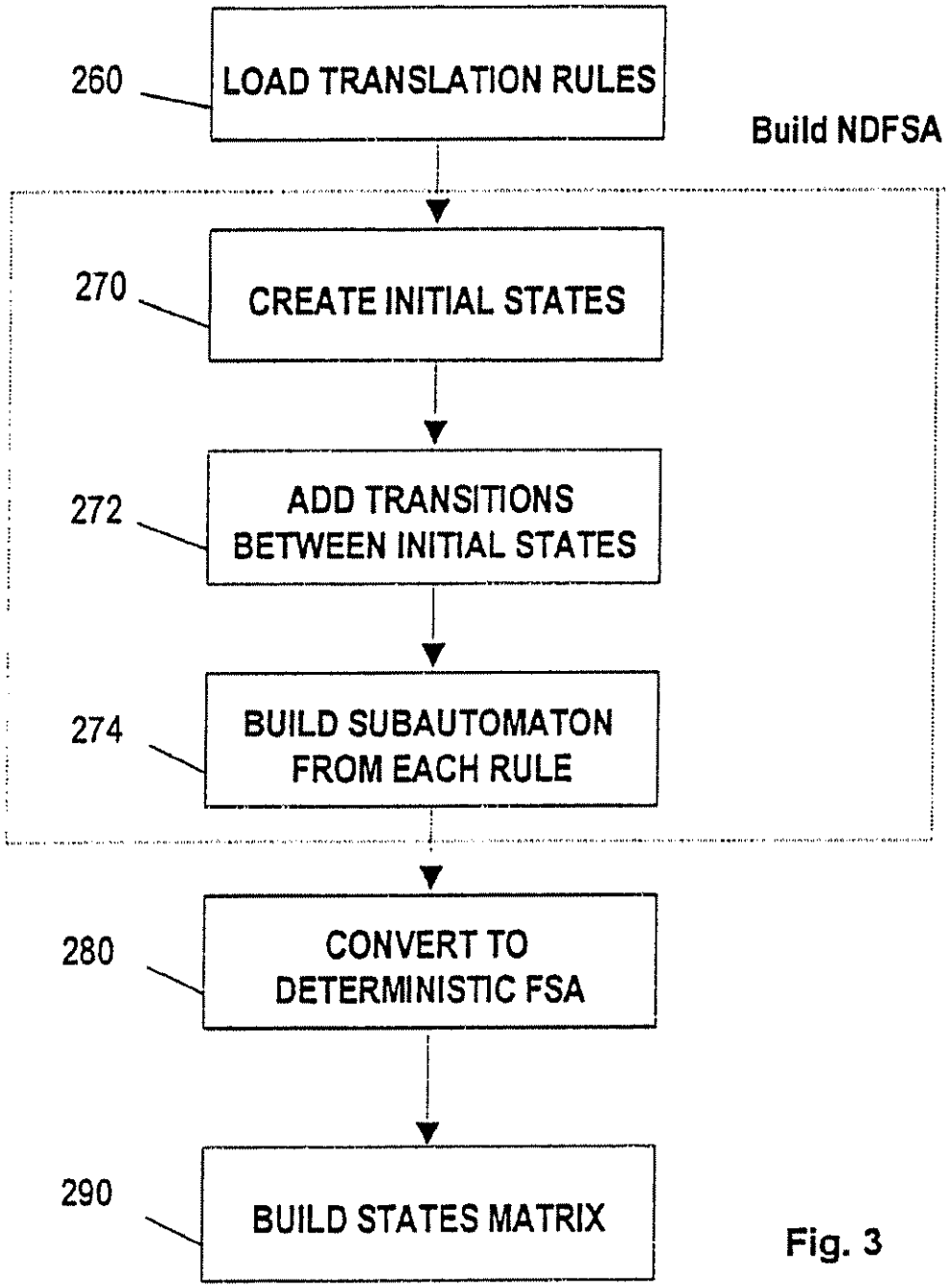

260
LOAD TRANSLATION RULES
Build NDFSA
270
CREATE INITIAL STATES
272
ADD TRANSITIONS BETWEEN INITIAL STATES
274
BUILD SUBAUTOMATON FROM EACH RULE
280
CONVERT TO DETERMINISTIC FSA
290
BUILD STATES MATRIX

Fig. 3

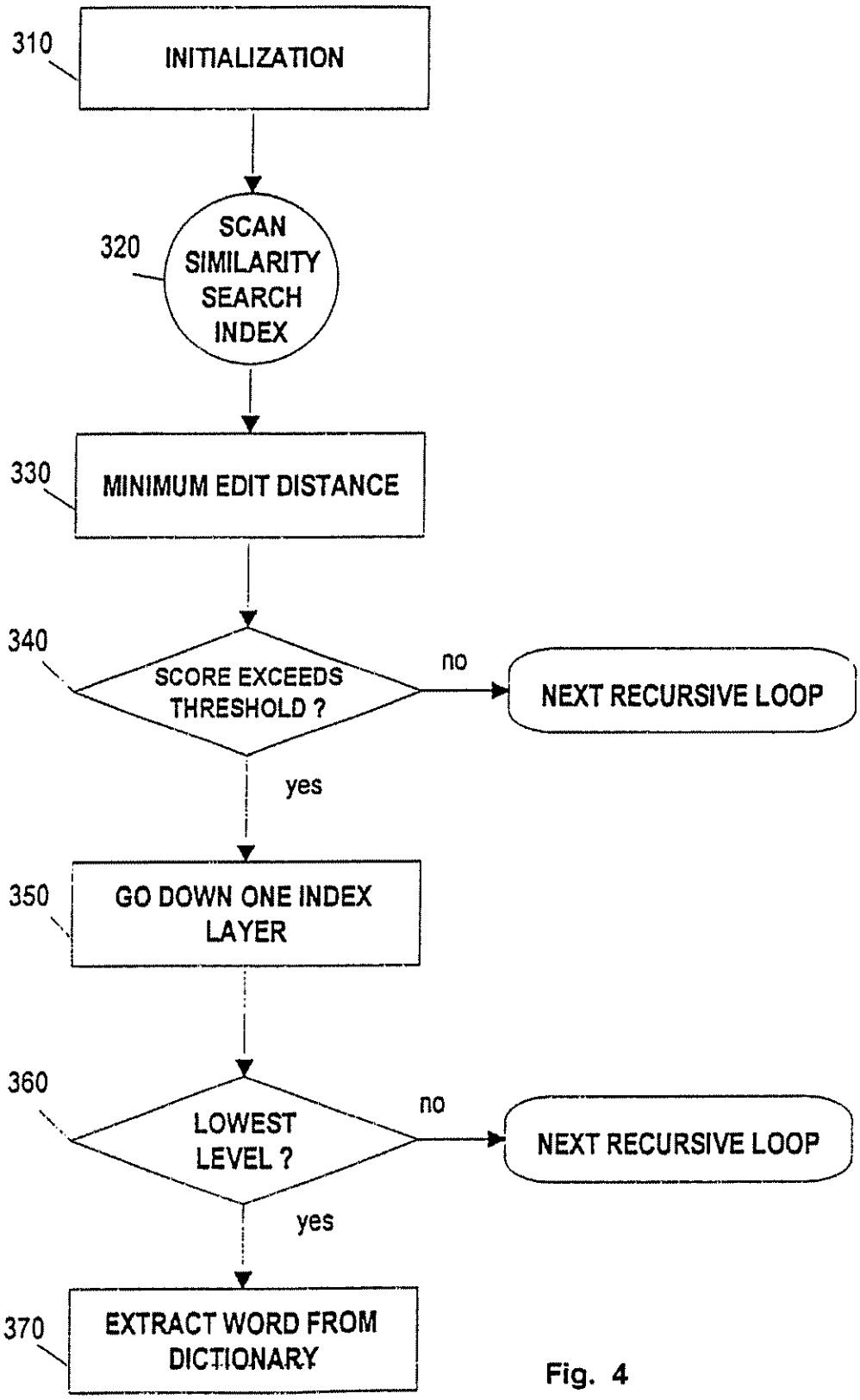

310
INITIALIZATION
320
SCAN SIMILARITY SEARCH INDEX
330
MINIMUM EDIT DISTANCE
340
SCORE EXCEEDS THRESHOLD ?
no
NEXT RECURSIVE LOOP
yes
350
GO DOWN ONE INDEX LAYER
360
LOWEST LEVEL ?
no
NEXT RECURSIVE LOOP
yes
370
EXTRACT WORD FROM DICTIONARY

Fig. 4

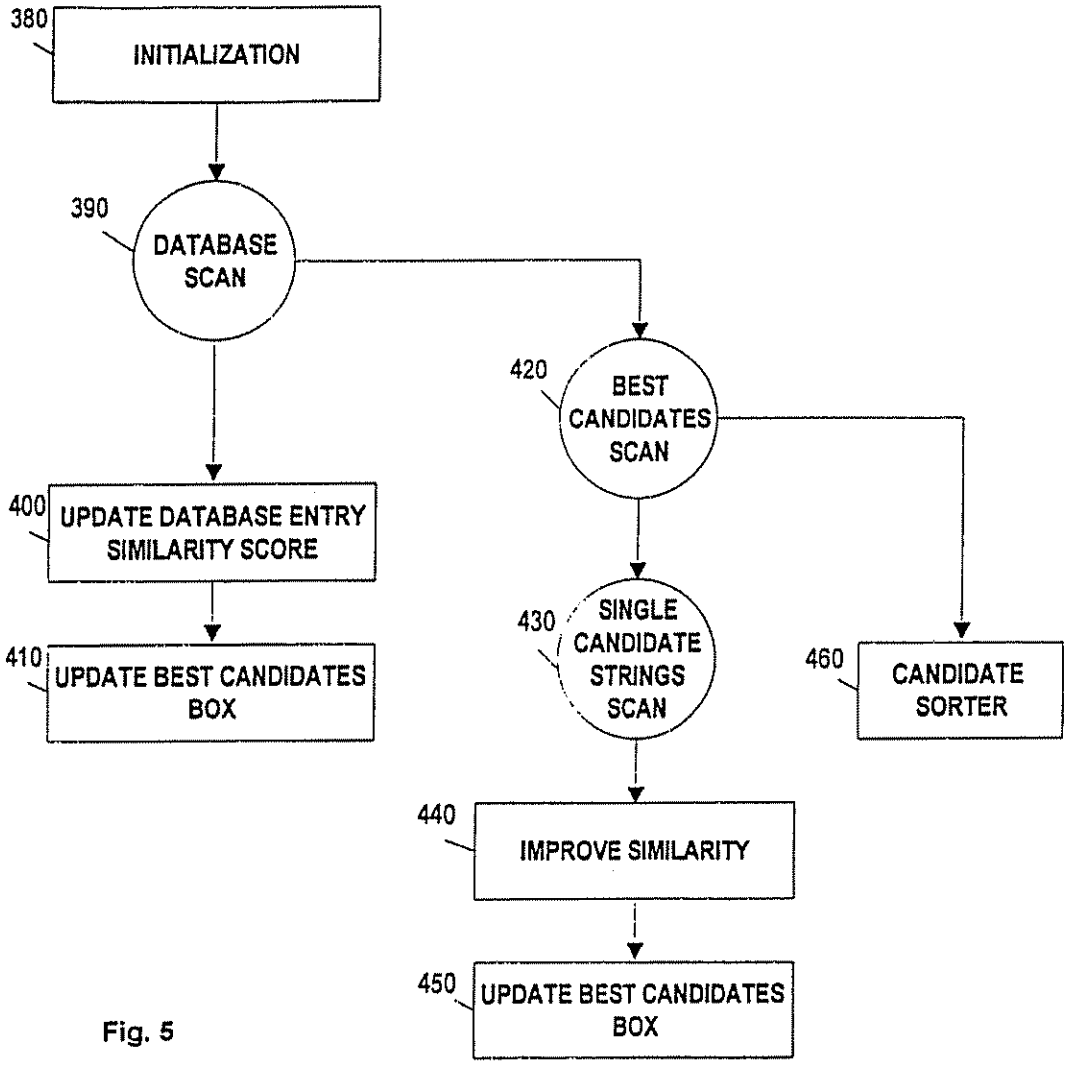

380
INITIALIZATION
390
DATABASE SCAN
420
BEST CANDIDATES SCAN
400
UPDATE DATABASE ENTRY SIMILARITY SCORE
410
UPDATE BEST CANDIDATES BOX
430
SINGLE CANDIDATE STRINGS SCAN
460
CANDIDATE SORTER
440
IMPROVE SIMILARITY
450
UPDATE BEST CANDIDATES BOX

Fig. 5

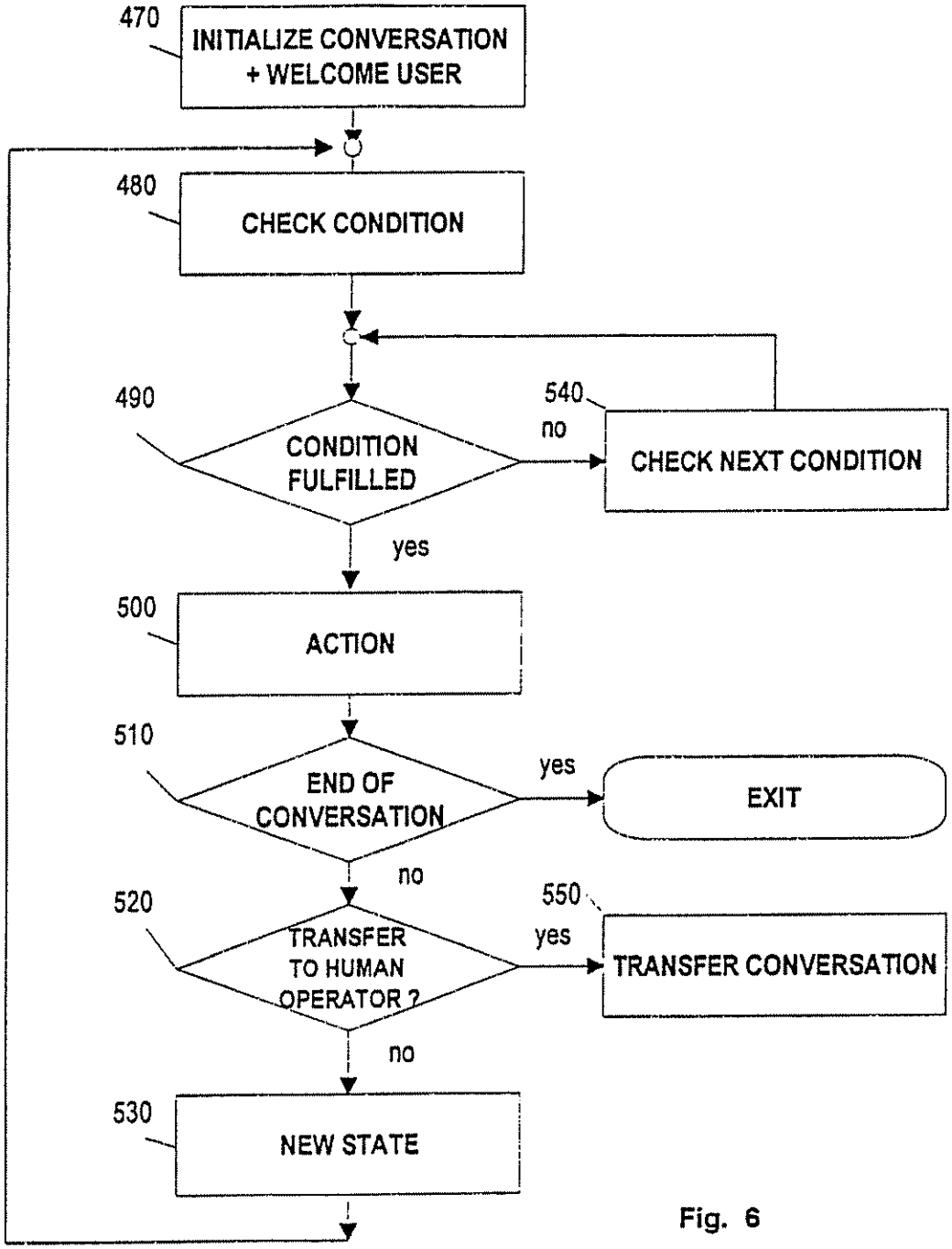

470
INITIALIZE CONVERSATION + WELCOME USER
480
CHECK CONDITION
490
CONDITION FULFILLED
no
540
CHECK NEXT CONDITION
yes
500
ACTION
510
END OF CONVERSATION
yes
EXIT
no
520
TRANSFER TO HUMAN OPERATOR ?
yes
550
TRANSFER CONVERSATION
no
530
NEW STATE

Fig. 6

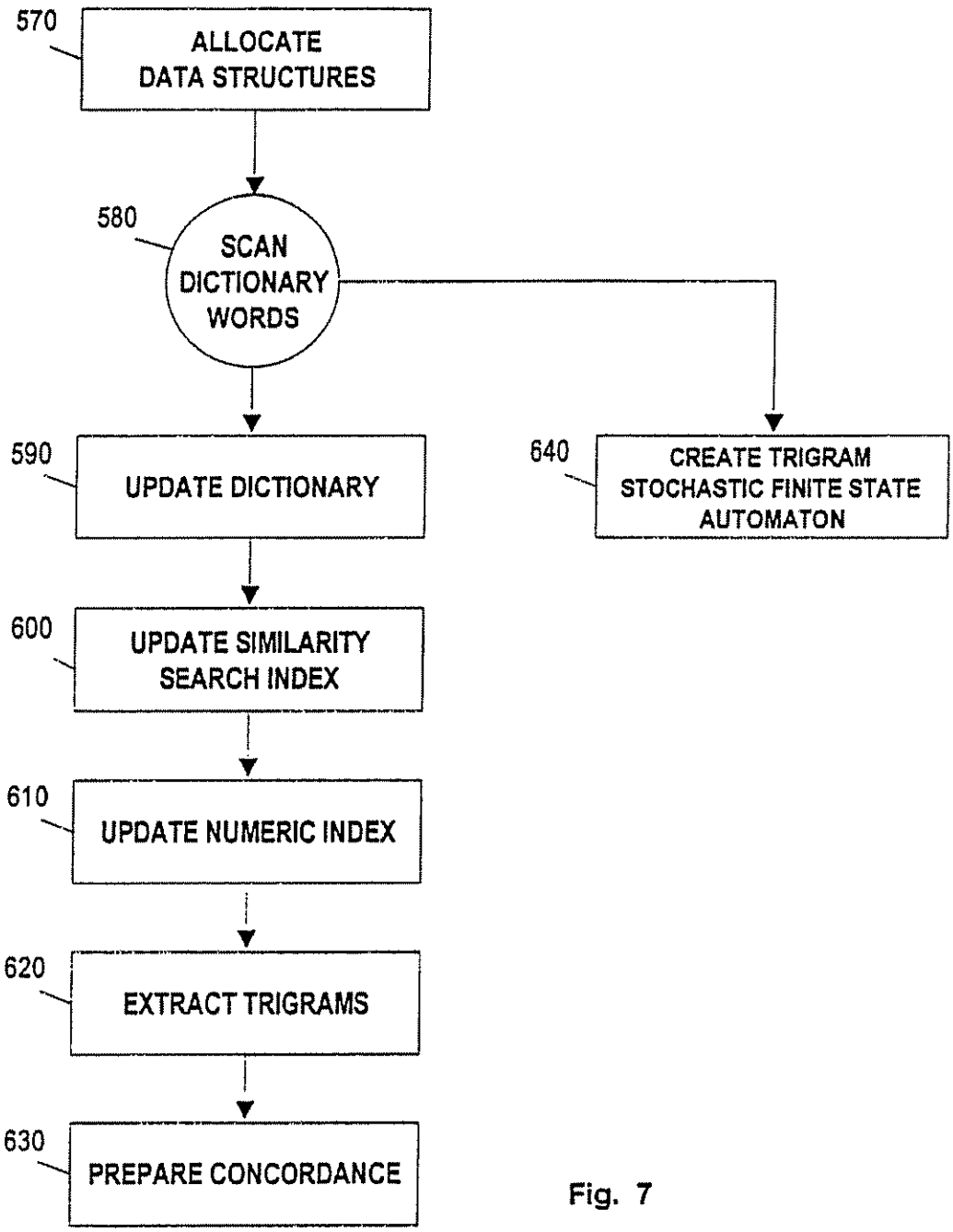

570
ALLOCATE DATA STRUCTURES
580
SCAN DICTIONARY WORDS
590
UPDATE DICTIONARY
640
CREATE TRIGRAM STOCHASTIC FINITE STATE AUTOMATON
600
UPDATE SIMILARITY SEARCH INDEX
610
UPDATE NUMERIC INDEX
620
EXTRACT TRIGRAMS
630
PREPARE CONCORDANCE

Fig. 7

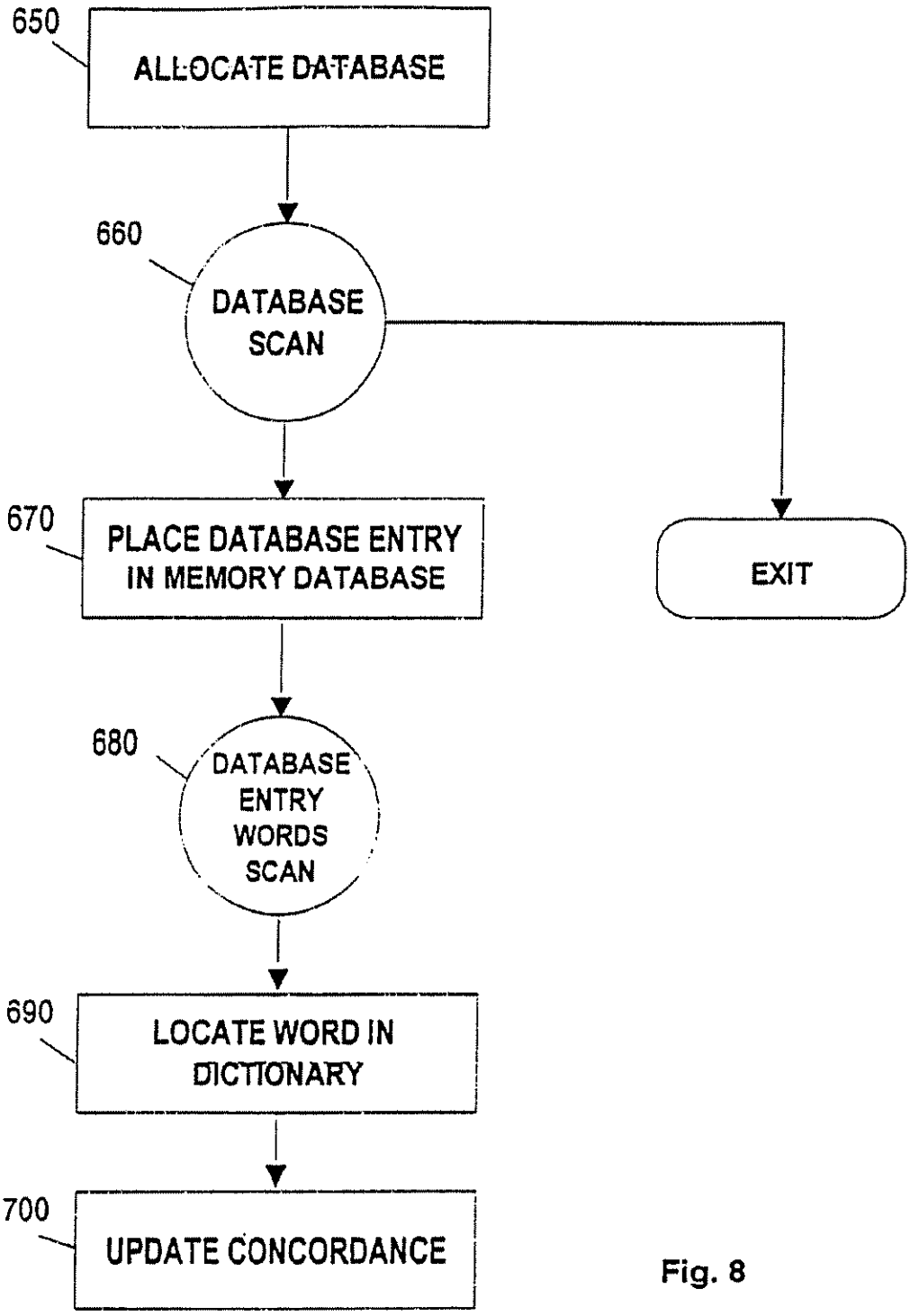

650
ALLOCATE DATABASE
660
DATABASE SCAN
670
PLACE DATABASE ENTRY IN MEMORY DATABASE
EXIT
680
DATABASE ENTRY WORDS SCAN
690
LOCATE WORD IN DICTIONARY
700
UPDATE CONCORDANCE

Fig. 8

FIG. 9

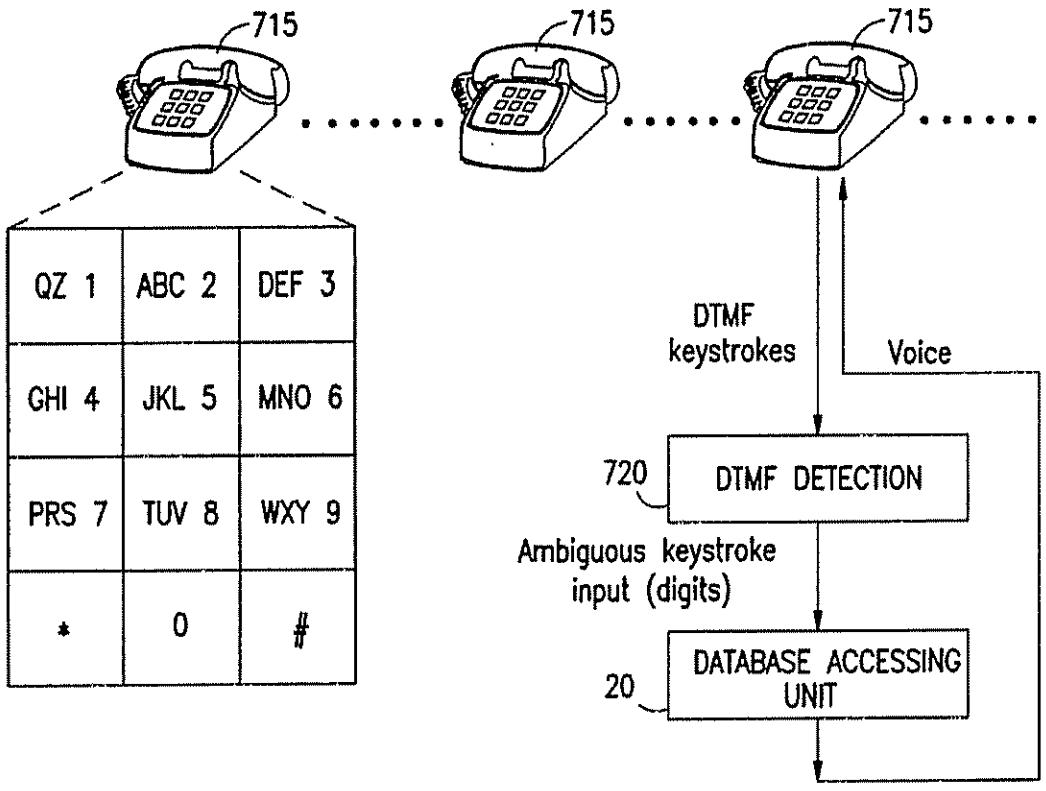

715
715
715
QZ 1
ABC 2
DEF 3
GHI 4
JKL 5
MNO 6
PRS 7
TUV 8
WXY 9
*
0
#
DTMF keystrokes
Voice
720
DTMF DETECTION
Ambiguous keystroke input (digits)
20
DATABASE ACCESSING UNIT

FIG. 10

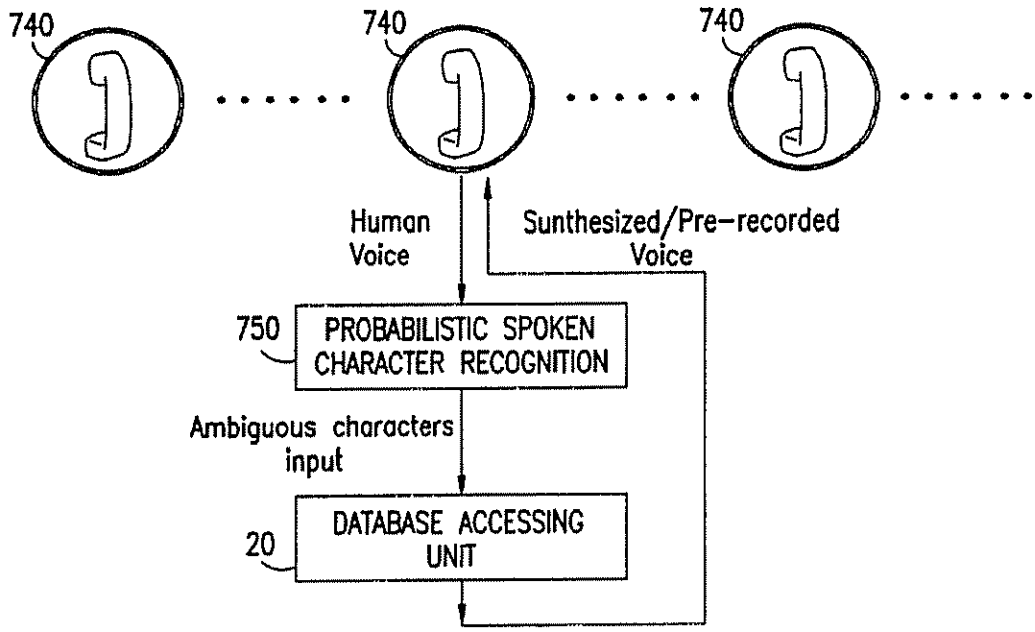
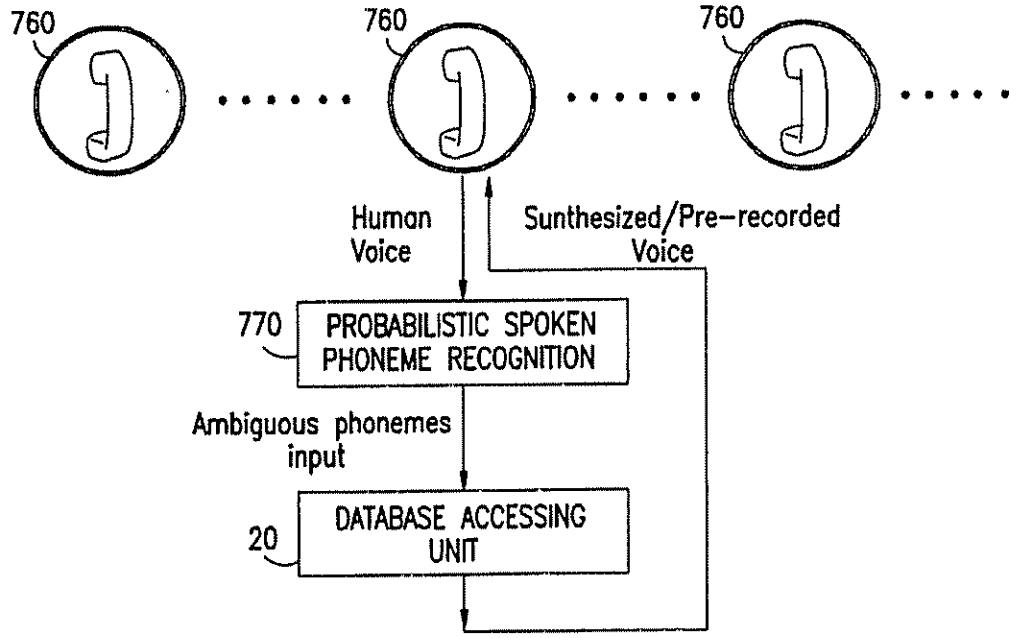

740
740
740
Human Voice
Sunthesized/Pre-recorded Voice
750
PROBABILISTIC SPOKEN CHARACTER RECOGNITION
Ambiguous characters input
20
DATABASE ACCESSING UNIT

FIG. 11


760
760
760
Human Voice
Sunthesized/Pre-recorded Voice
770
PROBABILISTIC SPOKEN PHONEME RECOGNITION
Ambiguous phonemes input
20
DATABASE ACCESSING UNIT

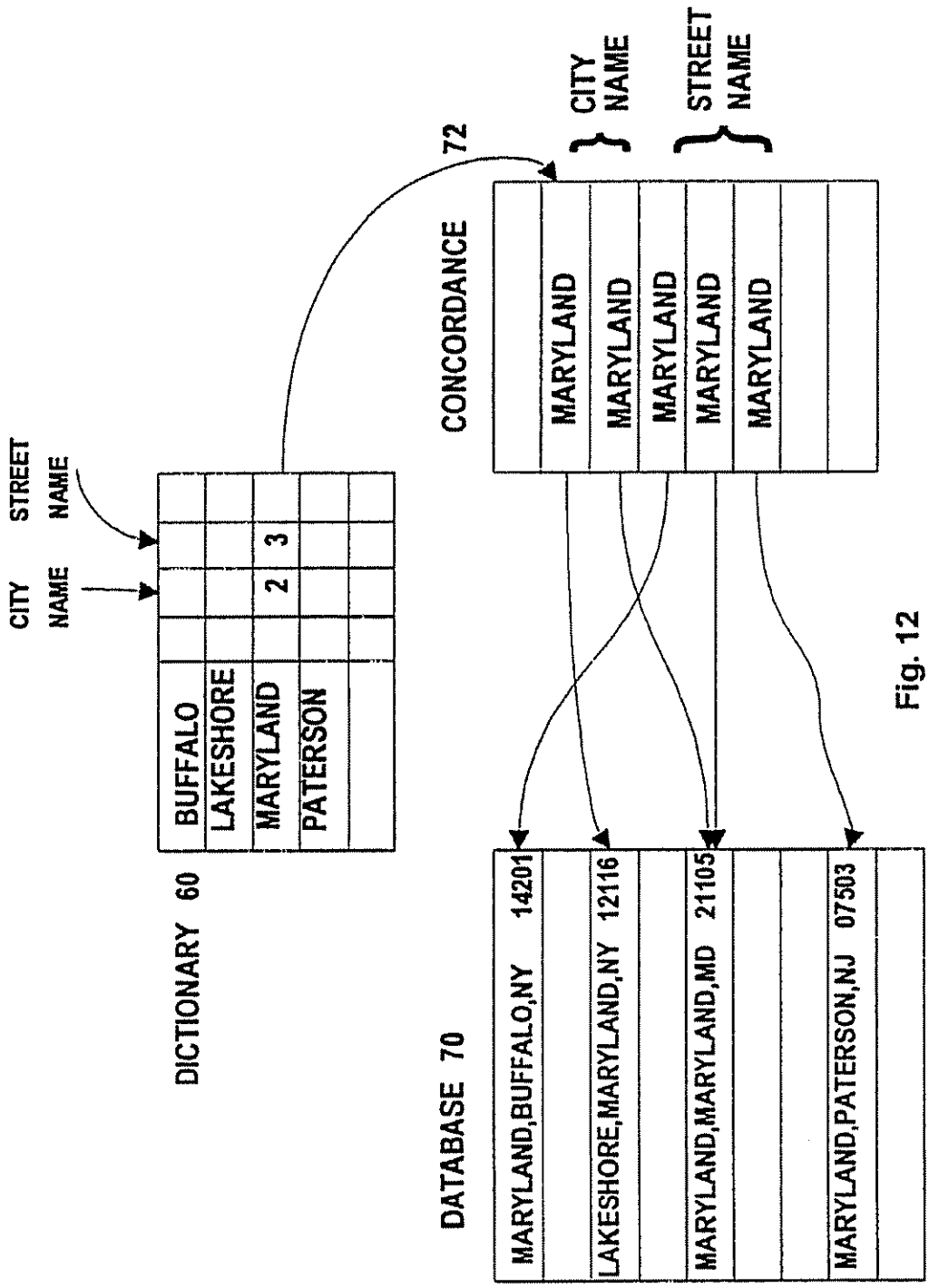

CITY NAME
STREET NAME
DICTIONARY 60
BUFFALO
LAKESHORE
MARYLAND
PATERSON
2
3
72
CONCORDANCE
CITY NAME
STREET NAME
MARYLAND
MARYLAND
MARYLAND
MARYLAND
MARYLAND
DATABASE 70
MARYLAND,BUFFALO,NY 14201
LAKESHORE,MARYLAND,NY 12116
MARYLAND,MARYLAND,MD 21105
MARYLAND,PATERSON,NJ 07503

Fig. 12

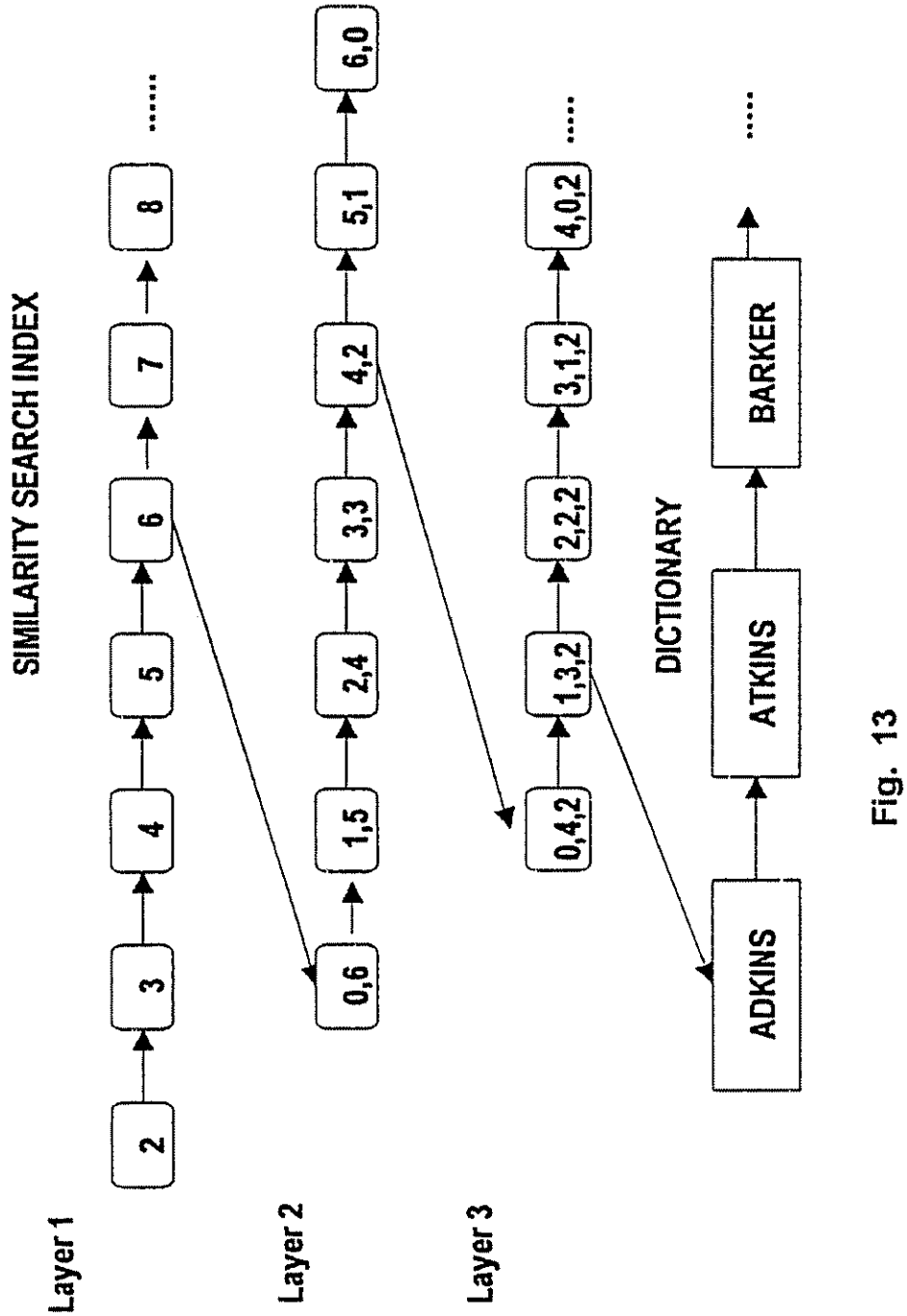

SIMILARITY SEARCH INDEX
Layer 1
Layer 2
Layer 3
DICTIONARY
2
3
4
5
6
7
8
.....
0,6
1,5
2,4
3,3
4,2
5,1
6,0
0,4,2
1,3,2
2,2,2
3,1,2
4,0,2
.....
ADKINS
ATKINS
BARKER
.....

Fig. 13

WORD-CONTAINING DATABASE ACCESSING SYSTEM FOR RESPONDING TO AMBIGUOUS QUERIES, INCLUDING A DICTIONARY OF DATABASE WORDS, A DICTIONARY SEARCHER AND A DATABASE SEARCHER

This application is a continuation of application Ser. No. 08/749,374, filed Nov. 20, 1996, U.S. Pat. No. 6,018,736, which is a continuation of application Ser. No. 08/317,040, filed Oct. 3, 1994, abandoned.

MICROFICHE APPENDIX

This application contains a microfiche appendix consisting of 8 microfiche and 782 frames.

FIELD OF THE INVENTION

The present invention relates to methods and apparatus for accessing databases generally and for accessing databases via the telephone, in particular.

BACKGROUND OF THE INVENTION

Publications describing conventional methods and systems for accessing databases via the telephone and publications on subjects related to these technologies, such as speech recognition publications, include the following:

U.S. Pat. No. 4,608,460 to Carter, entitled "Comprehensive Automatic Directory Assistance Apparatus and Method Thereof;

WO Patent 88/02965 to Daudelin, entitled "Directory Assistance Call Processing and non-Supervisory Signal Monitoring Arrangements";

U.S. Pat. No. 4,650,927 to James, entitled "Processor Assisted Communication System using Tone-Generating Telephones";

U.S. Pat. 5,255,310, to Kim, entitled "Method of Approximately Matching an Input Character String with a Key Word and Vocally Outputting Data";

U.S. Pat. No. 4,674,112 to Kondraske, entitled "Character pattern Recognition and Communications Apparatus";

U.S. Pat. No. 5,214,689 to O'Sullivan, entitled "Interactive Transit: Information System";

WO Patent 89/00793 to Padden, entitled "Directory Assistance Systems";

U.S. Pat. No. 4,979,206 to Padden, entitled "Directory Assistance Systems";

U.S. Pat. No. 5,131,045 to Roth, entitled "Audio-Augmented Data Keying";

U.S. Pat. No. 5,052,038 to Shepard, entitled "Apparatus and Method for Obtaining information in a Wide-Area Telephone System with Digital Data Transmission Between a Local Exchange and an Information Storage Site";

U.S. Pat. No. 3,928,724 to Byram, entitled "Voice-Actuated Telephone Directory--Assistance System";

Church K. W., Phonological Parsing in Speech Recognition, Kluwer Academic Publ, 1987;

Colangelo R. D., "Directory Assistance for the Visually Impaired", SouthEastcon 89, Vol 3, pp. 1168–1171, 1989;

Fast L., Ballantine R., "Dialing a Name: Alphabetic Entry Through a Telephone Keypad", SIGCHI, Vol 20(2) pp 34, 1988;

Glowacz D., "RBOCs Vocalize Operator Services", Telephone Engineer & Management, Vol 95(7) pp. 25–30, 1991;

Holmgren J. E., "Toward bell System Applications of Automatic Speech Recognition", The Bell System Technical Journal, Vol 62(6) pp. 1865–1881, 1983;

Jack M. A., "Design and Evaluation of Automated Telephone Services", IEE Colloquium on Telecommunications, pp. 61–64, 1992;

Klatt D. H., "Review of Text-to-Speech Conversion for English", Journal of the Acoustical Society of America, Vol 82(3) pp. 737–793, 1987;

Lennig M., "Putting Speech Recognition to Work in the Telephone Network", Computer, Vol 23(8) pp. 35–41, 1990;

Myers C. S., Rabiner L.R., "An Automated Directory Listing Retrieval System based on Recognition of Connected Letter Strings", Journal of the Acoustical Society of America, Vol 71(3), pp. 716–727, 1982;

Ohyama Minoru, "A Knowledge-Based Directory Assistance System", Future Generation Computer Systems, Vol 5(1) pp. 109–117, 1989;

Pelto G. E., "Designing the Telephone Interface for Voice Processing Applications", Speech Technology, Vol 5(1) pp. 18–21, 1989;

Schalk T. B., "Automating Operator-Assisted Calls Using Speech Recognition", Eurospeech 89, Vol 1 pp 441–444, 1989;

Veith R. H., "Information Retrieval via Telephone Keypad and Voice: Experiences with Telephone Directories", National Online Meeting Proceedings, Vol 1 pp 443–451, 1990;

Veith R. H., "Operator Assisted Services with Automated Responses",Audiotex, Vol 1 pp. 19–28, 1986;

Rabiner L., Juang B., Fundamentals of Speech Recognition, Prentice-Hall, 1993, pp. 43–52;

Hall, P. A. "Approximate string matching", Computing surveys, Vol. 12(4), pp. 381–402, 1980;

Salomaa, A., "Computation and Automatation", Cambridge University Press, 1985, pp. 44–55;

Tremblay, J. P.; Sorenson, P. G., "An introduction to data structures with applications", McGraw-Hill, 1976, pp 316–318;

Vitale, T. "An algorithm for high accuracy name pronunciation by parametric speech synthesizer", Computational Linguistics, Vol. 17(3), pp. 257–276, 1991;

Lorenz, A., Stochastic Automata Constructive Theory, John Wiley and Sons, 1974; and

Aldefeld, B "Automated directory listing retrieval system based on isolated word recognition",Proceedings of the IEEE, Vol 68(11), pp. 1364–1379, 1980.

The disclosures of all above references and publications cited therein are hereby incorporated by reference.

SUMMARY OF THE INVENTION

The present invention seeks to provide an improved system for accessing a computerized database from a location which is not in computer communication with the database.

There is thus provided in accordance with a preferred embodiment of the present invention a database accessing system for processing a request to access a database including a multiplicity of entries, each entry including at least one word, the request including a sequence of representations of possibly erroneous user inputs, the system including a similar word finder operative, for at least one interpretation of each representation, to find at least one database word which is at least similar to that interpretation, and a database entry evaluator operative, for each database word found by the similar word finder, to assign similarity values for relevant entries in the database, the values representing the degree of similarity between each database entry and the request.

Further in accordance with a preferred embodiment of the present invention the request includes a sequence of unambiguous representations of possibly erroneous user inputs

Still further in accordance with a preferred embodiment of the present invention the relevant entries include all database entries having the database word in an individual context

Additionally in accordance with a preferred embodiment of the present invention the request includes a sequence of ambiguous representations of possibly erroneous user inputs and also including an ambiguous input evaluator operative to identify at least one interpretation of each ambiguous representation and to provide the interpretation to the similar word finder.

Further in accordance with a preferred embodiment of the present invention the ambiguous input evaluator includes a database analyzer operative to extract database characteristics from the database.

Still further in accordance with a preferred embodiment of the present invention the system also includes a session manager receiving similarity values from the database entry evaluator and operative to interactively provide a user sensible message based on the similarity values.

Additionally in accordance with a preferred embodiment of the present invention the session manager is operative to prompt the user to provide the request by orally spelling at least one database word.

Further in accordance with a preferred embodiment of the present invention the session manager is operative to prompt the user to provide the request by pronouncing at least one database word.

Still further in accordance with a preferred embodiment of the present invention the session manager is operative to prompt the user to provide the request by keying at least one database word on the keypad.

There is additionally provided in accordance with a preferred embodiment of the present invention a database accessing system for processing a request to access a database including a multiplicity of entries, each entry including at least one word, the request including at least one ambiguous representation of at least one possibly erroneous user input, the system including an ambiguous input evaluator operative to identify at least one interpretation of each ambiguous representation, a similar word finder operative, for at least one interpretation of each representation, to find at least one database word which is at least similar to that interpretation, and a database entry evaluator operative, for each database word found by the similar word finder, to assign similarity values for relevant entries in the database, the values representing the degree of similarity between each database entry and the request.

Further in accordance with a preferred embodiment of the present invention the relevant entries include all database entries having the database word in an individual context

Still further in accordance with a preferred embodiment of the present invention the ambiguous input evaluator includes a database analyzer operative to extract database characteristics from the database.

Yet further in accordance with a preferred embodiment of the present invention the system also includes a session manager receiving similarity values from the database entry evaluator and operative to interactively provide a user sensible message based on the similarity values.

Additionally in accordance with a preferred embodiment of the present invention the session manager is operative to prompt the user to provide the request by orally spelling at least one database word.

Further in accordance with a preferred embodiment of the present invention the session manager is operative to prompt the user to provide the request by pronouncing at least one database word.

Yet further in accordance with a preferred embodiment of the present invention the session manager is operative to prompt the user to provide the request by keying at least one database word on the keypad.

There is still further provided in accordance with a preferred embodiment of the present invention a database accessing method for processing a request to access a database including a multiplicity of entries, each entry including at least one word, the request including a sequence of representations of possibly erroneous user inputs, the method including finding, for at least one interpretation of each representation, at least one database word which is at least similar to that interpretation, and assigning similarity values for relevant entries in the database, for each database word found, the values representing the degree of similarity between each database entry and the request.

There is provided in accordance with a preferred embodiment of the present invention a database accessing method for processing a request to access a database including a multiplicity of entries, each entry including at least one word, the request including at least one ambiguous representation of at least one possibly erroneous user input, the method including identifying at least one interpretation of each ambiguous representation, finding, for at least one interpretation of each representation, at least one database word which is at least similar to that interpretation, and for each database word found by the similar word finder, assigning similarity values for relevant entries in the database, the values representing the degree of similarity between each database entry and the request

In the present specification and claims, many examples from zip code database applications are provided in which address information is provided and, in response, the zip code of the address is accessed However, the term "database" as used herein is intended to include any type of database including but not limited to databases including financial and commercial data, databases including administrative data such as personnel data, transportation vehicle flight schedule databases, databases including technological data such as weather data, and databases including population data such as zipcode directories, classified and unclassified telephone directories.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated from the following detailed description, taken in conjunction with the drawings in which:

FIG. 1 is a high level functional block diagram of a database access system constructed and operative in accordance with a preferred embodiment of the present invention;

FIG. 2 is a flowchart illustrating a preferred method of operation for the spellguess unit of FIG. 1;

FIG. 3 is a flowchart illustrating a preferred method for generating the phonetic translator of FIG. 1;

FIG. 4 is a flowchart illustrating a preferred method of operation for the dictionary lookup unit of FIG. 1;

FIG. 5 is a flowchart illustrating a preferred method of operation for database lookup and candidate sorter units of FIG. 1;

FIG. 6 is a flowchart illustrating a preferred method of operation for the conversation manager of FIG. 1;

FIG. 7 is a flowchart illustrating a preferred method for loading the dictionary, similarity index, numeric index and trigram stochastic finite state automaton into memory, as well as for preparing the concordance;

FIG. 8 is a flowchart illustrating a preferred method for loading the database into memory and for updating the concordance prepared by the method of FIG. 7;

FIG. 9 is a simplified block diagram of one implementation of the apparatus of FIG. 1 in which the ambiguous input comprises telephone keypad input;

FIG. 10 is a simplified block diagram of one implementation of the apparatus of FIG. 1 in which the ambiguous input comprises output of a probabilistic spoken character recognition device;

FIG. 11 is a simplified block diagram of one implementation of the apparatus of FIG. 1 in which the ambiguous input comprises output of a probabilistic spoken phoneme recognition device;

FIG. 12 is a diagram of the computer memory data structures serving the apparatus of FIG. 1, including a dictionary, concordance and database storing typical data and the internal connections between these structures;

FIG. 13 is a diagram of a similarity search index, storing typical data, which is useful in performing the dictionary look-up method of FIG. 4.

Attached herewith are the following appendices which aid in the understanding and appreciation of one preferred embodiment of the invention shown and described herein:

Microfiche Appendix A is a computer listing of a preferred software implementation of a telephone directory database access system;

Microfiche Appendix B is an example of an alphabet definition file.

Microfiche Appendix C is an example of a "resource" file.

Microfiche Appendix D is an example of a "conversation manager decision table" file.

Microfiche Appendix E is an example of an "error messages" file.

Microfiche Appendix F is an example of a "phonetic translation rules" file.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to FIG. 1 which is a high level functional block diagram of a database access system constructed and operative in accordance with a preferred embodiment of the present invention

The database access system includes an ambiguous input generator **10** and a database accessing unit **20** accessing a database on the basis of ambiguous input received from generator **10**. The ambiguous input generator **10** provides ambiguous input such as ambiguous keystroke input or ambiguous speech input such as ambiguous oral character input or ambiguous oral phoneme input, as illustrated below with reference to FIGS. **9–11** respectively.

The output of the ambiguous input generator **10** is received by a spellguess unit **30** which is operative to select at least one string of symbols to which the ambiguous input might correspond, and preferably a plurality of strings of symbols, each associated with a probability. Each string of symbols may, for example, comprise a string of characters such as English language letters or may comprise a string of phonemes suitable for representing the dictionary alphabet. For example, the output of the spellguess unit may comprise the N most probable strings and their probabilities, where N is any suitable number such as **20**.

A preferred method of operation for spellguess unit **30** is described below with reference to FIG. **2**.

A phonetic translator **40** receives the possible strings generated by spellguess unit **30** and translates each of them into phonetic form. A preferred method for generating translator **40** is described below with reference to FIG. **3**. If translator **40** is generated by the method of FIG. **3**, the complexity of phonetic translator **40** is independent of the number of phonetic rules as described below with reference to FIG. **3**. Alternatively, however, conventional phonetic translation methods may be employed such as the methods described in the following publication:

Vitale, T. "An algorithm for high accuracy name pronunciation by parametric speech synthesizer", Computational Linguistics, Vol. 17(3), pp. 257–276, 1991.

In the illustrated embodiment, the phonetic translator converts strings in the English alphabet to strings in a phonetic alphabet such as the DECvoice phonetic alphabet developed by Digital Equipment Corporation. More generally, however, the phonetic translator may be operative to translate strings from any first alphabet into any second alphabet. The DECvoice phonetic alphabet is described in the following publication:

Klatt, D. H., "Review of text-to-speech conversation for English", Journal of the Acoustical Society of America, Vol. 82(3), p. 769.

Alternatively, the phonetic translator may be omitted in which case the access to the dictionary may be based directly on the guessed strings rather than on the translation of the guessed strings into phonetic form.

A dictionary look up unit **50** receives each phonetic or alphabetical string and conducts a similarity search within a dictionary **60**.

A preferred method of operation for dictionary lookup unit **50** is described below with reference to FIG. **4**.

The dictionary **60** comprises an alphabetical or phonetically ordered or otherwise ordered list of some or all words or strings appearing in the database **70** which is to be accessed. A concordance **72** associates the dictionary **60** with the database **70**. A similarity search index **74** allows the dictionary **60** to be searched for entries which are similar to a desired user-selected string. A numeric index **76** is provided if a telephone keypad is used which extracts from the dictionary all entries having a given numerical code. A trigram stochastic finite state automaton **78** stores trigrams and their probabilities and is accessed by spellguess unit **30**, as described in more detail below.

Dictionary **60**, database **70**, concordance **72**, numeric index **76** and trigram stochastic finite state automaton **78** may be stored in any suitable electronic medium such as a hard disc or RAM. A preferred method for loading the

dictionary, similarity index, numeric index and trigram automaton into memory, as well as for preparing the concordance, is described below with reference to FIG. 7. A preferred method for loading the database into memory and for updating the concordance prepared by the method of FIG. 7 is described below with reference to FIG. 8.

Alternatively, the dictionary **60** may comprise the database itself, particularly if the database is small and/or if the database does not include many duplicated strings.

The output of the dictionary lookup unit **50** typically comprises, for each string received from unit **30** or **40**:

a. A possibly empty list of dictionary entries whose similarity to the string is better than or equal to a predetermined similarity threshold; and

b. A similarity score representing the degree of similarity between that entry and the corresponding string.

EXAMPLE: The operation of spellguess unit **30**, phonetic translator **40** and dictionary lookup **50** for the following ambiguous telephone keypad input: 228437463 is now described.

Spellguess unit **30** guesses various spellings, among which, for the purposes of this example, the word CATHERINE is assumed to appear. This word is input to the phonetic translator **40**, which may translate it into (K Ae Th Eh R Ih N). The phonetically translated string is sent to the dictionary look up unit **50**, which may produce the following list of dictionary words and corresponding similarity scores: (KATHERINE, 100), (CATHERINE, 100), (CATHYRINE, 95), (KATHERYN, 92), (KATHRINE, 92), (KATHRYN, 85), (CATHRYN, 85).

According to one embodiment of the present invention, the database **70** is now accessed by a database look up unit **90** so as to identify, for each dictionary entry, all database entries which include that dictionary entry.

Preferably, however, the database entries identified by database lookup **90** for each dictionary entry include only those database entries which include the dictionary entry in the correct context. For example, in zip code directory applications, a conversation manager **80** may direct the user to enter the name of the city of interest and subsequently to enter the name of the street of interest. In this case, the database entries identified for a dictionary entry comprising a putative street name comprise only those database entries having that street name.

Database lookup unit **90** generates and continually updates, as the call or database access session progresses, a similarity vector **92**. The similarity vector **92** has a number of vector components which correspond to the number of database entries. Each similarity vector component stores a similarity score of the corresponding database entry. This similarity score is provided by the dictionary lookup **50** for each user-supplied word as the database access session proceeds. The database lookup **90** accumulates these similarity scores in the appropriate locations within the similarity vector.

After each word is supplied by the user, and the similarity vector is updated by the database lookup **90**, or concurrently with the updating process, a candidate sorter **100** extracts a predetermined number of the highest scoring similarity vector components and stores these components in a best candidates box **94**. The similarity vector **92** and best candidates box **94** are preferably stored in computer memory and are initialized at the beginning of each database access session.

A preferred method of operation for units **90** and **100** is described below with reference to FIG. **5**.

The conversation manager **80** receives the output of unit **90** or **100** and determines a course of action. The considerations of the conversation manager may, for example, include the following:

a. If one database entry has a similarity score which significantly exceeds the similarity score of all other candidates and which exceeds a threshold similarity score, this entry may be deemed correct and therefore is presented to the user for confirmation.

b. Typically, each entry in database **70** comprises a plurality of words or strings. For example, each entry in a zipcode directory typically includes some or all of the following words: state name, street name, street type, house number, locality. If this is the case, and processing of one string (such as "locality") does not provide a conclusive indication of the correct database entry, the conversation manager may decide to prompt the user to enter information identifying another word within the desired database entry (such as "street name").

c. If a small number of entries have similar or identical scores, the conversation manager may decide to present all of these to the user and prompt the user to select one of them about which s/he wishes to receive more information.

d. If a large number of entries have similar or identical scores and all strings within the entry have been processed, the conversation manager may wish to refer the user to the services of a human operator. In this case, the conversation manager **80** provides a suitable routing instruction to conventional telephone equipment which routes the user to a human operator.

A preferred method of operation for conversation manager **80** is described below with reference to FIG. **6**.

The output of the conversation manager is a suitable message to the user which is received by a text-to-speech voice synthesizer **110**, such as DECvoice, commercially available from Digital Equipment Corporation, Maynard, Mass., USA or Text Assist, commercially available from Creative Labs, Inc., Milpitas, Calif., USA. Alternatively or in addition, the output of the conversation manager may be received by a pre-recorded voice player **115** which plays a selected message from among a plurality of recorded messages. Examples of a commercially available voice player **115** include the DECvoice or Sound Blaster, commercially available from Creative Labs, Inc., Milpitas, Calif., USA. The text-to-speech voice synthesizer **110** and/or the voice player **115** provide an audible message which is transmitted over the telephone line to the user.

As described briefly above, the apparatus of FIG. **1** utilizes the following data structures in order to perform a similarity dictionary lookup, rather than an exact match lookup, and to support spell guess functions:

a. Word dictionary **60**—A list of entries which includes a single entry for each uniquely spelled database word for which direct access is required.

For example, if the database is a zip code directory, the words in the database which are to be accessed directly may include only the localities or alternatively, the state as well as the street name and locality. The dictionary includes a count for every word appearance in the database in the specific context, and a pointer to the concordance. For example, if the word MARYLAND appears in the database as a state name, a city name and a street name, the dictionary will contain only a single entry for the word MARYLAND, with separate counters for the number of times the word appears as state name, city name and street name, and a single pointer to the concordance, which points to the first occurrence of the word MARYLAND in the concordance

b. Concordance **72**—A list of entries including a single entry for each occurrence of each dictionary word in the database. Concordance entries relating to the same dictionary word are always arranged consecutively and sorted, within the dictionary word, according to the entry context (for example, appearances of the dictionary word in a locality context, followed by appearances of the dictionary word in a street name context). Each database entry is pointed to by all concordance entries corresponding to that database entry.

For example, the following database entry:

573 MARYLAND, BUFFALO, N.Y. 14201

will be pointed to by a corresponding MARYLAND entry in the concordance, a corresponding BUFFALO entry in the concordance and a corresponding NY entry in the concordance.

If database entries residing in consecutive addresses correspond to a plurality of concordance entries residing in consecutive addresses, the plurality of concordance entries may be replaced by a single entry pointing to the range of database entries.

The associations between the database, dictionary and concordance are illustrated in the diagram of FIG. **12**.

c. Similarity search index **74**—An index into the word dictionary that enables access to the word dictionary by word similarity rather than by exact match of words.

The similarity search index is preferably organized as an N-ary tree in which each node points to its left son and its right brother. An N-ary tree is a well-known data structure which is described in Tremblay, J. P.; Sorenson, P. G., "An introduction to data structures with applications", McGraw-Hill, 1976, pp. 316–318.

The similarity search index is built in several tree layers, such as 7 or 9 layers. Each layer corresponds to a different "reduced alphabet" of the dictionary alphabet, which may be either graphic or phonetic. One example of a reduced alphabet for the English language alphabet is an alphabet including. only two symbols, c for consonants and v for vowels. The correspondence between the English alphabet and the reduced alphabet is that all consonants are replaced by c and all vowels are replaced by v. More generally, a reduced alphabet is an alphabet that contains less symbols than an original alphabet and complies with the following criteria:

1) each symbol in the reduced alphabet represents a group of symbols of the original alphabet;

2) a symbol of the original alphabet appears in only one group; and

3) the union of all groups comprises the complete original alphabet.

Each layer of the similarity search index contains the same dictionary words but in a different reduced alphabet.

Each word in the similarity search index is represented in vector format with a reduced alphabet. A word in vector format is represented by a vector V of length L, where L is the number of symbols in the alphabet. Each element Vi of the vector contains the number of occurrences of the ith alphabetic symbol in the word. For example, given an alphabet {a,b,c} and a word "abbac", the vector representation is "2,2,1". To continue the above example of the {c,v} alphabet, the words BLAKE and GRACE will both be expressed by the pair "2,3". Each layer of the similarity search index is built with a different reduced alphabet adhering to the above guidelines.

FIG. **13** illustrates an example of a "grapheme based" similarity search index for an English language dictionary. It is appreciated that, alternatively, a phonetic-based similarity search index may be employed. The index of FIG. **13** is an N-ary tree which includes the following three layers:

Layer **1** is based on a single symbol reduced alphabet which transforms each English language word into its length.

Layer **2** is based on a two symbol alphabet, which transforms each English word into an ordered pair (a,b) where a is the number of consonants in the word and b is the number of vowels.

Layer **3** is based on three symbols, which transforms each English word into an ordered triplet (a,b,c) where a is the number of letters from among the set (P, F, B, V, W, T, D) in the word, b is the number of letters from among the remaining consonants in the word and c is the number of vowels in the word.

Each dictionary word is mapped to one node in each index layer. For example, the word ADKINS appearing in FIG. **13** is mapped into node (**6**) in layer **1** since ADKINS contains 6 letters, into node (**4,2**) in layer **2**, since ADKINS contains 4 consonants and 2 vowels, and into node (**1,3,2**) in layer **3** since only the letter D belongs to the set (P, F, B, V, W, T, D), and there are 3 other consonants, and 2 vowels.

d. Numeric index **76**—This index is organized as a balanced tree, and is employed when the ambiguous input generator is a keypad in which one number is used to represent a plurality of letters, such as a telephone keypad. The numeric index uses the ambiguous numeric input value keyed in by the user of the keypad to point directly to all dictionary entries having that numeric input value.

e. Trigram stochastic finite state automaton **78**—An automaton that stores all trigrams appearing in the dictionary along with, their probabilities which are computed based on dictionary appearance frequencies. The trigram stochastic finite state automaton is employed by spell guess unit **30** to anticipate the probable spelling of any given ambiguous string.

Reference is now made to FIG. **7** which illustrates a preferred method for loading the dictionary, similarity index, numeric index and trigram automaton into computer memory, as well as for preparing the concordance in the computer memory.

The method of FIG. **7** preferably includes the following processes:

a. Allocate data structures (process **570**)—This process creates the initial structures for the word dictionary, the concordance, similarity search index, the numeric index and the trigram stochastic finite state automaton.

b. Scan dictionary words (process **580**)—This loop reads all dictionary words from a dictionary organized as a sequential disk file. For each word the following processes are performed:

i. Update word dictionary (process **590**)—This process copies the word into the dictionary.

ii. Update similarity search index (process **600**)—The word is translated into the reduced alphabet of every layer of the index. All index layers are searched, from the highest to the lowest level, and any missing words are added.

iii. Update numeric index (process **610**)—If the numeric code of the word does not exist in the index, it is added. Once the numeric code of the word does exist, a pointer is added to it which points at the newly entered word.

iv. Extract trigrams (process **620**)—All trigrams contained in the new word are stored in a temporary list.

Each time a trigram on the list appears, an associated frequency value is incremented. The trigram list including frequency values are employed to construct the automaton in process **640**, once all dictionary words have been processed by loop **580**.

Prepare concordance entries (process **630**)—Each dictionary word occupies one or more entries in the concordance. The concordance entries are created at this time, but are not associated with database entries pointers until the database itself is loaded into memory.

c. Create trigram stochastic finite state automaton (process **640**)—Based on the trigram information (population and frequencies) accumulated by process **620**, a stochastic finite state automaton is built. This automaton will be later used by spellguess unit **30** to guess the spelling of the ambiguous input string. A stochastic finite state automaton is described in the above-referenced publication by Lorenz.

Reference is now made to FIG. **8** which illustrates a preferred method for loading the database into memory and for updating the concordance prepared by the method of FIG. **7**.

The method of FIG **8** preferably includes the following processes:

a. Allocate database (process **650**)—Prepares the memory required to hold the entire database.

b. Database scan loop **660**—Reads a plurality of database entries stored in sequential format and residing on magnetic media, such as hard disk drive. For every database entry, the following processes are performed:

I. Place database entry in memory database (process **670**)—Finds the next available place in memory database, places the database entry there, sets a direct pointer from every database word to the dictionary, and keeps the direct memory address in order to allow further direct addressing to the entry (from the concordance).

II. Inner database entry word scan loop (process **680**)—Scans all the database entry words that are defined as requiring direct access through the dictionary and concordance. For every such word, the process performs the following two processes:

i. Locate word in dictionary (process **690**)—Since the dictionary is loaded before the database, and since every word requiring direct access has to be present in the dictionary, this process locates the word entry in the dictionary, in order to locate the right entry in the concordance, that corresponds to this database entry.

ii. Update concordance (process **700**)—Adds a pointer from the concordance entry to the database entry. This pointer establishes a link between a dictionary word and the corresponding database entries.

Reference is now made to FIG. **2** which illustrates a preferred method of operation for spellguess unit **30**. As described above, spellguess unit **30** is preferably operative to select a plurality of strings of characters to which ambiguous input might correspond, each associated with a probability. In the illustrated embodiment, the output of the spellguess unit is the N most probable strings and their probabilities, where N is any guitable number such as **20**.

The method of FIG. **2** preferably includes the following processes:

a. An initialization process **140** in which an initial string is constructed. The process then invokes a recursive string lengthening process **144**, until all possible spelling alternatives have been checked.

b. A recursive string lengthening process **144** including blocks **150–220** which generates a list of the N most probable strings and their probabilities, based on preknown frequencies of various "trigrams" or 3-letter strings in the dictionary. Process **144** receives as input a partial string of length L whose probability has already been computed and computes the probability of at least one string of length L+1 which includes the input partial string. If the length of the partial string is less than 3 (if trigram frequencies are employed), the partial string is taken to include two "dummy" characters such as two #'s.

c. Output process **230**—the N most probable strings are copied onto a digital storage medium such as computer memory. Preferably, the N most probable strings are retained as a heap sorted by their probabilities.

For example, suppose that the numeric string "2874" is a keypad input to spellguess unit **30**, which is intended by the caller to represent the name "BUSH". Spellguess unit **30** uses the method of FIG. **2** in order to produce a list of the most probable strings represented by the numeric string "2874", along with their probabilities.

An example of such a list is as follows:(BURG, 0.1611), (BURI, 0.1259), (CURG, 0.1118), (BUSH, 0.1086), (CUSH, 0.1018), (CURI, 0.0874).

As described in detail below, the probability of an individual candidate string is based on the probabilities of each trigram included in the string. For example, the probability assigned to BURG might be roughly the product of the known frequencies of occurrence of each of the following trigrams: BUR, URG.

The blocks of the recursive spellfinding process are now described in detail:

Block **150**: "Minimum probability" is typically 0 if less than N strings have been accumulated. If N strings have already been accumulated, "minimum probability" is equal to the probability of the least probable of the N strings.

If the probability of the input partial string is less than "minimum probability", the process backtracks to tho previous recursive level because the probability of the input partial string will only decline further as its length increases.

Block **160**: If the partial string is, in fact, a "final" string, i.e. a string of the length which the user entered, then it is entered onto a list, typically organized as a heap, of most probable strings (block **190**). Otherwise, the process advances directly to block **200**.

If the list already contains N strings (block **170**), the lowest probability string is discarded (block **180**) before the new string is inserted (block **190**).

At this point, the string is lengthened by considering the possible characters which might fill the (L+1)'th position in the string. For example, if keypad input is employed and the user punched the #2 key for the L+1'th position, the candidate characters are A, B and C. For each candidate character, blocks **210** and **220** are performed.

Block **210**: The candidate character is concatenated with the partial string and the probability of the new, longer partial string is defined by generating the product of the probability of the previous partial string and the probability of the trigram consisting of the last three characters of the new, longer partial string.

Block **220**: The next recursive level of the string lengthening process begins, thereby to add yet another character to the current partial string.

Reference is now made to FIG. **3** which illustrates a preferred method for generating phonetic translator unit **40**. As described above, phonetic translator unit **40** is preferably

operative to convert strings from one alphabet (such as English), into another alphabet (such as the DECvoice phonetic alphabet). The complexity of the phonetic translator is n, where n is the length of the string to be converted, regardless of the number of phonetic translation rules The method of rig. 3 preferably includes the following processes:

Process **260**: Load translation rules: read an external file that describes phonetic translation rules for translating between the alphabets employed. For example, Appendix F is a description of the phonetic translation rules for translating from English to DECvoice Preferably, the syntax of the external file is checked. The structure of a rule is as follows:

grapheme→phoneme/"preceding substring"_"following substring"

The above rule instructs the phonetic translator to translate a certain grapheme to a certain phoneme if the grapheme is preceded by a certain "preceding substring" and is followed by a certain "following substring". Any of the phoneme, preceding substring and following substring can be empty.

Following are some examples of phonetic translation rules:

BB→B double Bs sound like a single B (BUBBLE)

PH→F P followed by H always sound like F (PHONE)

O→Uh/W_L. O preceded by W and followed by L, sounds like the phoneme Uh (WOLF)

Y→Ay/c_cE Y preceded by any consonant and followed by a consonant that is followed by E, sounds like (BYTE)

A non-dete(rministic automaton ig now generated. Processes **270**, **272** and **274** create a single non-deterministic finite state automaton (NDFSA) from all the phonetic translation rules loaded in process **260**. Each of these processes is now described in detail:

Process **270**: Build states **S0**, **S1** and **S2** where: **S0** is the initial state for all rules that have 2 characters in their "preceding substring" **S1** is the initial state for all rules that have 1 character in their "preceding substring", and **S2** is the initial state for all rules that do not have a "preceding substring".

Additional states may be defined similarly if it is desired to accommodate preceding strings which are more than 2characters long.

Process **272**: Add unconditional transitions from **S0** to **S1** and from **S1** to **S2** such that the entire grapheme alphabet causes the automaton to proceed from state SO to S1 or from **S1** to **S2**.

Process **274**: Build a subautomaton for each phonetic rule The subautomaton for an individual phonetic rule has n states, where n is the total number of characters in the "preceding substring",the grapheme and the "following substring". The last, n'th, state is also termed herein the Accepting State. Add transitions from each state to the next state which are respectively determined by the characters of the preceding substring, grapheme and following substring The output generated by the subautomaton is the phoneme which the rule in question associates with the preceding substring, grapheme and following substring

For example, the rule O→Uh/W_L, has 3 states, such as for example (**S10**,**S11**,**12**) and 3 transitions: W as preceding substring causes a transition from the initial state to state **S10**, O as grapheme causes a transition from **S10** to S11, and L as following substring causes a transition from S11 to the accepting state **S12**. The output of the subautomaton for the above sample rule is the phoneme (Uh). Since this rule has one character, W, in the "preceding substring", then state S1 serves as its initial state. Therefore, the subautomaton for this rule comprises the following transitions: (S1,W,S10), (S10,O,S11), (S11,L,S12)

Process **280**: Convert the non-deterministic automaton (NDFSA) constructed in processes **270–274** into a deterministic finite state automaton (DFSA) including all the phonetic translation rules The conversion process may be based on well known methods, such as the conversion method described in Salomaa, A., *Computation and automata*, Cambridge University Press, 1985, pp. 44–55.

Process **290**—Build states matrix: Convert the DFSA created by process **280** into a matrix, where the rows correspond respectively to the states in the DFSA and the columns correspond respectively to the possible inputs i e to the grapheme alphabet. The contents of each matrix cell includes: the next state, whether the state is an accepting state or not, and the phoneme generated by an accepting state.

Once the phonetic translator **40** has been generated as described above, the phonetic translator is operative to translate a graphic word into a phonetic word as follows:

Given a graphic word, such as a word in English, apply the states matrix created in process **290** thereon, and output a phonetic word, which is the phonetic representation of the input grapheme word. The following examples illustrate the outputs of the phonetic translator unit **40** for a variety of inputs:

grapheme input word: BUBBLE phonetic output word: B Ah B L

grapheme input word: PHONE phonetic output word: F Ao N

grapheme input word: BYTE phonetic output word: B Ay T

grapheme input word: WOLF phonetic output word: W Uh L F

Reference is now made to FIG. 4 which illustrates a preferred method of operation for dictionary lookup unit **50** of FIG. **1**.

The input to the dictionary look up unit **50** are the strings that were guessed by spelIguess unit **30**, if the phonetic translator is omitted from the system of FIG. **1**, or the strings that were generated by the phonetic translator unit **40**. Dictionary look up unit **50** does not search for an exact match with the input strings, but rather performs a similarity search in order to find all dictionary words that are similar, to a predetermined extent, to the input strings, if not necessarily identical. Dictionary look up Rio uses a similarity threshold in order to define the predetermined extent of similarity.

The method of FIG. 4 preferably includes the following process:

a. Initialization (process **310**)—Determine the similarity threshold to be used. Appendix C is a resource file in which one suitable similarity threshold is defined The string for which it is desired to find similar dictionary words is translated into each of the reduced alphabets of the layers in the similarity search index. For example, if it is desired to find dictionary words which are similar to ADCINS using the similarity index illustrated in part in FIG. **13**, ADCINS is translated into (6) in the layer **1** alphabet, (4,2) in the layer **2** alphabet, and (1,3,2) in the layer **3** alphabet

b. Scan similarity search index (process **320**). A similarity search index, the structure of which is described above with reference to FIG. **13**, is scanned recursively, layer

by layer, in order to find all dictionary words that are similar (better than or equal to the similarity threshold) to the input string arriving from spellguess **30** or translator **40**.

Process **320** recursively invokes processes **330–370** in order to perform a depth-first search for similar nodes. The search employs a conventional distance-between-strings computation method to compute the distance between each node and the input string represented in the reduced alphabet of the layer to which the node belongs.

A suitable method for computing distance between strings is described in Hall, P. A. "Approximate string matching", Computing surveys, Vol. 12(4), pp. 381–402, 1980.

Parameters may be externally defined to determine the relative costs of symbol insertion and symbol deletion, for each symbol in the dictionary and reduced alphabets and for symbol substitution, for each pair of symbols in the dictionary and reduced alphabets. For example, Appendix B is a sample "cost schedule" including costs for symbol insertion, deletion and substitution.

It is appreciated that either a spoken language alphabet or a phonetic alphabet may be used as the dictionary alphabet.

The output of this step is a set of all dictionary words whose similarity to the "dictionary alphabet" representation of the input string is equal to or exceeds the similarity threshold defined in the initialization process **310**.

Reference is now made to FIG. **5** which illustrates a preferred method of operation for the database lookup unit **90** and the candidate sorter unit **100** (FIG. **1**). The database lookup unit **90** accepts as input each individual dictionary entry in the list of dictionary entries generated by dictionary lookup unit **50** along with its similarity score, also computed by dictionary lookup unit **50**, and its entry context (last name, first name, etc.)

The database lookup unit **90** operates for each database entry component. For example, in zip code directory applications, the database lookup unit **90** operates after the state name is elicited from a user, then after the city's name is elicited and then after the street name is elicited. After each operation, the database lookup unit **90** updates the similarity vector **92** (FIG. **1**) such that the similarity vector accumulates a similarity score for each database entry.

The output of the database lookup **90** and the candidate sorter **100** is a list of a predetermined number of database entries which are most similar to the words supplied by the user thus far, sorted according to their similarity scores. This list if stored in the best candidates box **94** of FIG. **1**.

The method of FIG. **5** preferably includes t he following processes:

a. Initialization (process **380**)—Uses concordance **72** to find the logical and physical location of all database entries that include the requested dictionary entry value in the appropriate context. For example, if the user supping SMITH as a For name, all subscribers whose last name is similar to Smith will be located

If this is the first database look up in the database access session, initialization process **380** also clears the similarity vector **92** and the best candidates box **94**.

b. Database scan (process **390**)—Scans all the database entries that were selected by the initialization process **380**. For each entry, the following **2** processes are performed:

i. Update database entry similarity score (process **400**)—For each database entry, updates the similarity score by modifying the similarity score to reflect the degree of similarity of that database entry to the current word. For example, the word similarity score may be added to the appropriate similarity vector component.

ii. Update best candidates box (process **410**)—Determines whether or not the previously updated database entry has to be included in the best candidates list, based on the following criteria:

if the database entry is already in the best candidates box, it is kept there with the new score updated

if the best candidates box is not full, the database entry is added unconditionally

if the best candidates box is full and the similarity score of the updated database entry is higher than the last (worst score) database entry in the candidates box, the last database entry is replaced with the new one.

At the end of processes **380** through **410**, the similarity vector includes updated similarity scores and the contents of the best candidates box is determined. At this point, a candidate sorter **100** is invoked in order to resort the selected database entries in the best candidates box. The current ordering in the best candidates box is based on the sum of similarity scores of individual words where the similarity score of any word, if under a predetermined threshold, is considered to be zero. The candidates sorter computes the similarity of each zero-scoring word.

Specifically, the candidate sorter **100** preferably performs the following processes:

a. Best candidates scan (process **420**)—Scans all the database entries in the best candidates box

b. Single candidate words scan (process **430**)—Scans all the words of a single database entry in the best candidates box. This process decides whether the similarity score of any one of the database entry strings may be improved, according to the following criteria:

the word was supplied by the caller; and

the word's similarity score is 0.

For each of the words fulfilling this criteria, the process invokes **2** additional processes (improve similarity **440**, and update best candidates **450**), in order to refine the similarity scores, first at the word level and then at the database entry level.

c. Improve similarity scores (process **440**)—Reinstates a minimum edit distance similarity check, similar to process **330** in FIG. **4**, between a current database entry word in the best candidates box **94** and each word previously guessed by the spellguess unit **30**, using a lower threshold measure than that originally employed by process **330**. If the resulting simil larity score differs from 0, the word similarity score and the database entry similarity score are both updated in process **450**.

d. Update best: candidates box (process **450**)—Compute the total similarity score of each changed database entry in the best candidates box and the similarity vector

e. Candidate sorter (process **460**)—Sorts the entire best candidates box according to the similarity score, using a suitable conventional sort mechanism, such as a heap.

The output of the entire database lookup **90** and candidate sorter **100** is a list of all best candidates database entries, sorted according to their similarity scores.

Reference is now made to FIG. **6** which illustrates a preferred method of operation for the conversation manager **80**. The conversation manager controls the conversation between the caller and the system , from the moment the caller gains access to the computer and until the conversation is finished. The actions taken by the conversation manager, including message providing action, depend on the contents of the best candidates box **94**.

The conversation manager **80** is preferably implemented as a state machine whose logic is defined by a decision table. A sample decision table, which is internal to the system, is provided in Appendix D. However, the decision table is preferably completely external to the system to enable it to be easily modified.

The conversation manager **80** includes three building blocks: the state, the condition and the action. The conversation begins at the initial state, and each additional item of information: acquired, leads the conversation to a different state. At each state, the conversation manager checks for the first condition that is fulfilled, and performs the action that is associated with the state and the condition. After that, the conversation manager proceeds to the next state. For example, one state may be "beginning of conversation", a condition may be "was a word entered by caller?", and an action may be "propose a selection list", or "search the database".

The method of FIG. **6** preferably includes the following processes:

a. Initialize conversation+welcome user (process **470**)—Set the conversation to the initial state, and, typically, provide a welcome message, which includes the instructions for using the database access system.

b. Check condition (processes **480**, **490** and **540**)—Check whether the condition associated with the state is fulfilled or not. At least one condition has to be fulfilled per state, so the conversation manager loops until it finds the first one.

c. Action (process **500**)—Perform the action that is associated with the state and with the first condition that is fulfilled.

d. End of conversation (process **510**)—If the system enters the "end of the conversation" state, the conversation is ended

e. Transfer to operator (processes **520** and **550**)—If the conversation manager comes to the conclusion that the conversation has to be transferred to a human operator, it generates the appropriate routing instructions. This action may be useful, if for example, the conversation is too long, or the information provided by the caller does not identify a specific piece of information, or if the caller requests to be transferred to a human operator.

f. New state (process **530**)—The conversation manager proceeds to a new state, once it has finished handling the actions of previous state.

Reference is now made to FIG. **9** which is a simplified block diagram of one embodiment of the apparatus of FIG. **1** in which the ambiguous input comprises telephone keypad input. In the embodiment of FIG. **9**, the ambiguous input generator **10** of FIG. **1** includes a plurality of conventional telephone instruments **715** communicating via a telephone network with database accessing unit **20** via a conventional DTMF (dual tone multiple frequency) detection module **720** which is operative to convert the keystroke information into conventional digital data signals such as ASCII data signals.

In the embodiment of FIG. **9**, the ambiguous input is keystroke information wherein each key corresponds to more than one letter of the English alphabet and may also correspond to the digit corresponding to the key. The data is ambiguous because every letter is entered by a single stroke on one of the telephone keypad buttons, and every button represents up to 3 different letters. For example, button **2** represents either A or B or C, while button **3** represents either D or E or F. For example, the sequence of digits "2"; "3" could represent any of the following letter combinations: AD, AE, AF, BD, BE, BF, CD, CE, CF, as well as combinations of letters and the numbers "2" and "3". So, a string of length n can be interpreted in 3 to the power of n different ways. For example, a sequence of 6 keystrokes corresponds to 729 alternative words. For example, the names ARNOLD and BROOKE are keyed with the same keystroke sequence (276653). The same is true with names like BREEN and ARDEN (27336), or BUSH and BURG (2874).

Reference is now made to FIG. **10** which is another embodiment of the apparatus of FIG. **9** in which the ambiguous input is ambiguous oral character input rather than ambiguous keystroke input. In the embodiment of FIG **10**, the ambiguous input generator **10** of FIG. **1** comprises a plurality of telephone instruments **740** or other speech input devices providing ambiguous speech input to the database accessing unit **20** via a probabilistic spoken character recognition device **750**.

The probabilistic spoken character recognition device **750** is similar to conventional speech recognition units, except that the output is probabilistic. In other words, the final decision stage in which probabilistic input, as to the contents of the speech, is reduced to a single possibility, typically by selecting the most probable speech content, is omitted.

A design suitable for a probabilistic spoken character recognition device is described in Rabiner L., Juang B., *Fundamentals of Speech Recognition*, Prentice-Hall, 1993, pp. 43–52.

In this embodiment, the user is prompted to provide oral input by spelling the desired words. For example, the conversation manager may prompt the user to "SPELL THE STREET NAME YOU ARE LOOKING FOR."

The input provided by device **750** is ambiguous since the probabilistic spoken character recognition box **750** outputs several possible characters, along with their relative probabilities, for every input spoken character. For example, a user's attempt to utter a "D", may be interpreted by the probabilistic spoken character recognition box 750, as "B" with probability 0.5, "D" with probability 0.3, and "T" with probability 0.2. A subsequent utterance of the letter "D", may yield different output (letters and probabilities)

Reference is now made to FIG. **11** which is another embodiment of the apparatus of FIG. **1** in which the ambiguous input comprises ambiguous spoken phoneme input rather than ambiguous oral character input.

In the embodiment of FIG. **11**, the ambiguous input generator **10** comprises a plurality of telephone instruments **760** or other speech input devices, and a probabilistic spoken phoneme recognition box **770**. In this embodiment, the user is assumed to provide speech input in the form of spoken words. For example, the conversation manager may prompt the user to "STATE THE STREET NAME YOU ARE LOOKING FOR."

The probabilistic spoken phoneme recognition device **770** is similar to conventional speech recognition units, except that the output is phonemes with associated probabilities. In other words, the final decision stage in which probabilistic input, as to the contents of the speech, is reduced to a single possibility, typically by selecting the most probable speech content, is omitted. A suitable design for a probabilistic spoken phoneme recognition device is described in Rabiner L., Juang B., *Fundamentals of Speech Recognition*, Prentice-Hall, 1993, pp. 43–52.

For example, the word "DAVE" may be phonetically broken into the following phonemes: D, Ey and V (when using a certain phonetic alphabet).

When the word "DAVE" is input to a probabilistic spoken phoneme recognition box **770**, it may recognize every

phoneme in several ways, with a certain probability applied to every phoneme. For instance, the first phoneme may be expressed as "(D, 0.4), or (B, 0.4), or (T, 0.2)"; the second phoneme may be expressed as "(Ey, 0.6) or (Eh, 0.3), or (Ay, 0.1)"; and the third phoneme may be expressed as "(V, 0.8), or (B, 0.1), or (F, 0.1) ".

Microfiche Appendix A is a computer listing of a preferred software implementation of a telephone directory database access system which utilizes an "alphabet definition" file, a "resource" file, a "conversation manager decision table" file, an "error messages" file, and a "phonetic translation rules" file.

Microfiche Appendix B is an example of an alphabet definition file.

Microfiche Appendix C is an example of a "resource" file.

Microfiche Appendix D is an example of a "conversation manager decision table" file

Microfiche Appendix E is an example of an "error messages" file.

Microfiche Appendix F is an example of a "phonetic translation rules" file.

The terms "resource" file, "conversation manager decision table" file, "error messages" file, and "phonetic translation rules" file are now explained in detail.

The Alphabet Definition file contains a definition of the various alphabets used in the system, and the translation rules between the various alphabets. A description of an example of an alphabet definition file, appended hereto and referenced

Microfiche Appendix B is as follows:

The title "ALPHABETS" designates the beginning of the alphabet definition section. This section contains the following fields:

I. Name—The alphabet name. Note that the alphabets named "clusterX" are reduced alphabets

II. Type—The alphabet type. The permitted types are:

1. String—regular alphabet.
2. Normal—regular alphabet, but all the letters are kept normalized—i.e., instead of using the regular ASCII values to represent the alphabet letters, they are represented as consecutive numeric values starting from 1
3. Vector—an alphabet that is kept in vector form. A word in this A form comprises a vector, whose size is equal to the alphabet size. The i'th entry in the vector contains the number of occurrences of the respective letter in the word.

III. absize—size of the alphabet.

IV. Attribute—Information regarding the correct interpretation of the "value" field (field V). The permitted attributes are:

1. Letters—The "value" field contains the list of letters in the alphabet.
2. Cost—the "value" field contains the insertion cost, deletion cost and substitution cost, in that order, of the alphabet.
3. Inscost—the "value" field contains only the insertion cost of the alphabet.
4. Delcost—the "value" field contains only the deletion cost of the alphabet.
5. SubsX—the "value" field contains the costs of substituting each of the symbols of the alphabet for a symbol X in the alphabet which exists in a particular word. X may be represented by one or more characters. For phonetic alphabets, X is often represented by two characters

V. Value field

The title "TRANSLATION" in Microfiche Appendix B designates the beginning of the Translation section. This section contains the following fields:

I. From—the name of the source alphabet.

II. To—the name of the target alphabet.

III. From letters—letters from the source alphabet which are to be translated into the target alphabet.

IV. To letterg—the corresponding letters in the target alphabet.

Translations in which, generally speaking, one or more symbols in the source alphabet are translated into a unique symbol in the target alphabet appear in Microfiche Appendix B. However, the translation from a grapheme alphabet to a phonetic alphabet is not defined here but rather in the "phonetic translation rules" file, an example of which is appended hereto and is referenced. Microfiche Appendix F.

The term "Resource File" is now defined. An example of a resource file is appended hereto and is referenced as Appendix Microfiche C.

The resource file is a key translating logical names used by the system, such as file names, into actual values. Typically, the system recognizes only logical names for each file and each logical name is translated into a specific disk file with the help of the resource file. The resource file is also used for message texts, special run-time thresholds and switches.

Each line of the resource file contains three fields: logical name, actual value and remarks. The logical name may not contain blanks. If an actual value contains blanks, the actual value is truncated at the first blank. If blanks are to be inserted within the actual value, the actual value should be enclosed in apostrophes. In this case the actual value may span more than one line, provided that each line contains apostrophes at the beginning and end of the line.

The file may contain the #include directive, whose meaning is similar to that of the #include directive in the "C" programming language. This directive allows the inclusion of another resource file into the current resource file. Resource files may be nested in that manner to any desired nesting level.

In case the same logical name appears more than once, only the first occurrence is used. Thus it is possible to create a standard #include file that will contain default parameters. Those parameters can be overridden if the logical name appears before the #include of the standard file. The logical names of the resource file are case-insensitive. The resource file is loaded into memory by the loadResourceTable routine. The translation from logical name to actual value is performed by the member function "allocate" which belongs to class "ResourceBox", or by the member function "ValueOf", also belonging to the "ResourceBox" class.

The term "Conversation Manager Decision Table" is now described. An example of a "conversation manager decision table" is appended herein and is referenced Microfiche Appendix D. The conversation manager **80** of FIG. 1 is driven by a central decision table, which contains States, Conditions and Actions

The decision table contains one or more "Header" lines. Each Header line contains titles of all fields in the decision table. The first field is termed the "line label" field, the second field is termed the "state" field, and the rest of the fields are conditions (denoted by C in the title line) and actions (denoted by A in the title line).

The "line label", designated in the first field, is a unique identification of each line in the file. It is used in order to keep the "session history"—a log of the actions that were taken in the current session.

The conversation manager **80** of FIG. 1 scans the Decision Table line by line, and for each line checks if all the conditions in that line are met (i.e., have the required value), until a line is found which satisfies all the conditions. The actions of this conditions-satisfying line are performed in the order in which they appear in that line.

The Decision Table is compiled into a C++ source code by the routine "createDecisionTB". This is the source code of the "decide" member function which belongs to the "ConvManager" class.

The term "Error Messages" file refers to a file in which all possible error messages are stored. An example of an "error messages" file is appended hereto and is referenced Microfiche Appendix E.

Microfiche Appendix E contains a set of error messages that are displayed and written to the log file (error.log) in case an error occurs during the system execution. Each message is identified by a message name (up to 18 characters long), a severity code and message text. The permitted severity codes are: F for fatal, E for error, W for warning, and I for informational. A fatal error causes the system to abort. All other message types allow the system's execution to proceed.

Each error message may contain up to three parameters, which are enclosed in brackets, e.g. <file name>. Each parameter is replaced by an actual value when the error message is invoked. The "error" routine accepts the actual values and inserts them into the error message. Then it displays the error message on the screen, and writes it to the log file. For fatal errors—it aborts the system.

The "Phonetic Translation Rules" file contains all phonetic translation rules employed by phonetic translator **40** of FIG. 1 to translate grapheme words into a phonetic representation. An example of a "phonetic translation rules" file is appended hereto and is referenced Microfiche Appendix F.

The syntax for Phonetic Rules employed in Microfiche Appendix F is given below in BNF format. BNF is a conventional scheme for representing formal languages.

<rule>::=<grapheme string>→<phoneme string>|
<grapheme string>→<phoneme string>/<preceding substring>|
<grapheme string>→<phoneme string>/_<following substring>|<grapheme string>→<phoneme string>/<preceding substring>_<following substring>
<preceding substring>::=<grapheme sequence>
<following substring>::=<grapheme sequence>
<grapheme sequence>::=<grapheme letter>|
<grapheme sequence><grapheme letter>
<grapheme letter>::=<grapheme character>|!<grapheme character>
<grapheme character>::=grapheme ||v|c |[<grapheme string>]
<grapheme string>::=grapheme |<grapheme string>grapheme
<phoneme string>::=phoneme|<phoneme string>phoneme

A grapheme is a symbol in the grapheme alphabet as defined in the alphabet definition file. A phoneme is a symbol in the phoneme alphabet, as defined in the alphabet definition file. The dot ( ) represents a "don't care" symbol, and can stand for any grapheme symbol.

The lower-case v symbol stands for any vowel. The lower-case c symbol stands for any consonant. The square brackets enclose a list of alternative grapheme symbols. For example, the rule: G→Jh/_[EI] means: grapheme G is translated to phoneme Jh if it followed by either E or I.

A preferred method for generating a telephone directory database access system based on the listings of Microfiche Appendices A—F is as follows:

a. Provide the following hardware environment: fully compatible IBM PC 386 or higher, Sound Blaster audio card.

b. Provide the following software environment: MS-Windows 3.1, Monologue for Windows Text-to-Speech synthesizer from Creative Labs, Borland C++3.1 & Application Framework for Windows.

c. Microfiche Appendix A is written in C++, and contains classes as well as the source code itself. Compile and link the code of Microfiche Appendix A; thereby to create a single executable image.

d. Provide the following input files which are required to operate the system:

1. Database—according to the format described in class ListingRecord.
2. Dictionary—according to the format described in lass NameDictionary.
3. Alphabet definition—description of the alphabets used, and the various costs for spelling mistakes. An example of an alphabet definition file is Microfiche Appendix B.
4. Resource file—description of all files and parameters needed to run the system. An example of a resource file is Microfiche Appendix C.
5. Conversation manager decision table—description of the conversation flow. An example of a conversation manager decision table Eile is Microfiche Appenaix D.
6. Errors—the textual description of possible system errors. An example of an errors file is Microfiche Appendix E.
7. Phonetic translation rules—description of the phonetic rules. An example of a phonetic translation rules file is Microfiche Appendix F.

e. Run the executable image generated in step c.

In the illustrated embodiment, the following output files are created during system operation:

1. Error log—description of errors encountered during execution.
2. Log—information and statistics on a single use of the system.
3. Session—recording of the conversion handled in a single use of the system.

It is appreciated that the software components of the present invention may, if desired, be implemented in ROM (read-only memory) form. The software components may, generally, be implemented in hardware, if desired, using conventional techniques.

It is appreciated that the particular embodiment described in the Appendices is intended only to provide an extremely detailed disclosure of the present invention and is not intended to be limiting.

In the present specification and claims, the term "probabilistic string" refers to a sequence S over an alphabet A (such as the English alphabet, any non-English alphabet, the phonetic alphabet or any other set of characters) of n elements where each element S_i is a finite non-empty set of (character, probability) pairs.

The term "keypad" refers to an input device including a plurality of input buttons or keys each of which, separately or in combination with other input buttons or keys, represents one or more characters. For example, each key on a conventional telephone keypad represents three, two or only one characters.

The term "erroneous user input" refers to a database accessing request provided by a user which comprises an inaccurate production of a word in the database. The inaccuracy may comprise one, some or all of the following types of inaccuracy: spelling inaccuracy, pronunciation inaccuracy or factual inaccuracy.

The term "spelling inaccuracy" refers to a cognitive or typographical error which results in an incorrect spelling of a database word. For example, a user wishing to access a street name BROADWAY may key in or spell out BROAWDAY or DROADWAY. A user wishing to access a locality PHILADELPHIA may key in or spell out FILADELFIA.

The term "pronunciation inaccuracy" refers to an incorrect oral rendition of a database word. For example, a user wishing to access the name MARIE may state this request as "MARY".

The term "factual inaccuracy" refers to provision of incorrect information. For example, a user wishing to access JOHN REMINGTON may request JACK REMINGTON.

It is appreciated that the user accessing the system shown and described herein can be either a human user or a computerized system.

It is appreciated that the ambiguous input may, alternatively, comprise the output of an OCR (optical character recognition) device such as a handwriting recognition device.

It is appreciated that various features of the invention which are, for clarity, described in the contexts of separate embodiments may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment may also be provided separately or in any suitable subcombination.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention is defined only by the claims that follow:

What is claimed is:

1. A database accessing system for processing a database query, the database including a multiplicity of entries each of which has a predetermined structure comprising at least first and second words, the database query including a sequence of at least first and second inputs corresponding to said first and second words respectively, each input including a plurality of input elements, the system including;

a dictionary of all words in said database;

a dictionary searcher operative to find words in said dictionary which resemble each of said inputs and to assign to each found word a similarity score describing the degree to which said word resembles said input; and

a database searcher operative to use said similarity scores in order to find entries in said database whose words, have cumulative scores which indicate that they most resemble said query.

2. A system according to claim 1 wherein the similarity score assigned to an individual word depends only on the absolute degree of resemblance of the individual word to said input and does not depend on the relative degree to which the individual word resembles said input, in relation to the degrees to which other words in the dictionary resemble said input.

3. A system according to claim 1 wherein the words found by the dictionary searcher comprise all words which exceed a predetermined word-level resemblance threshold rather than comprising a predetermined number of best words.

4. A system according to claim 1 wherein said database searcher includes:

a candidate entry searcher operative to find all entries which exceed a predetermined entry-level resemblance threshold rather than comprising a predetermined number of best entries; and

a conversation manager operative, if more than one entries are found by the candidate entry searcher, to hold an interactive conversation with a human user in order to allow the human user to select from among the more than one entries found by the candidate entry searcher.

5. A system according to claim 1 wherein at least one of said inputs comprises a spoken word and at least one of said input elements comprises a phoneme.

6. A system according to claim 1 wherein at least one of said inputs comprises an orally spelled word and at least one of said input elements comprises an orally spoken letter.

7. A system according to claim 1 wherein at least one of said inputs comprises a sequence of keystrokes and at least one of said input elements comprises a keystroke.

* * * * *

JS 44
(Rev. 12/96)

CIVIL COVER SHEET

The JS-44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet (SEE INSTRUCTIONS ON THE REVERSE OF THE FORM)

I.(a) PLAINTIFF
Nuance Communications, Inc. and Phonetic Systems Ltd

(b) COUNTY OF RESIDENCE OF FIRST LISTED PLAINTIFF NCC
(EXCEPT IN U S PLAINTIFF CASES)

DEFENDANT
Telme Networks, Inc

COUNTY OF RESIDENCE OF FIRST LISTED DEFENDANT _____
(IN U S. PLAINTIFF CASES ONLY)
NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED

(c) ATTORNEYS (FIRM NAME, ADDRESS, AND TELEPHONE NUMBER)
Frederick L. Cottrell, III
Richards, Layton & Finger
One Rodney Square - P O Box 551
Wilmington, DE 19899
(302) 651-7700

ATTORNEYS (IF KNOWN)

II. BASIS OF JURISDICTION (PLACE AN X IN ONE BOX ONLY)

- ☐ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question (U S Government Not a Party)
- ☐ 2 U S Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III CITIZENSHIP OF PRINCIPAL PARTIES (PLACE AN "X" IN ONE BOX (For Diversity Cases Only) FOR PLAINTIFF AND ONE BOX FOR DEFENDANT)

	PTF	DEF		PTF	DEF
Citizen of This State	☐ 1	☐ 1	Incorporated *or* Principal Place of Business in This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business in Another State	☐ 5	☐ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

VI. ORIGIN (PLACE AN X IN ONE BOX ONLY)

☒ 1 Original Proceeding | ☐ 2 Removed from State Court | ☐ 3 Remanded from Appellate Court | ☐ 4 Reinstated or Reopened | ☐ 50 Transferred from another district (specify) | ☐ 6 Multidistrict Litigation | ☐ 7 Appeal to District Judge from Magistrate Judgment

V. NATURE OF SUIT (PLACE AN X IN ONE BOX ONLY)

CONTRACT
- ☐ 110 Insurance
- ☐ 120 Marine
- ☐ 130 Miller Act
- ☐ 140 Negotiable Instrument
- ☐ 150 Recovery of Overpayment & Enforcement of Judgment
- ☐ 151 Medicare Act
- ☐ 152 Recovery of Defaulted Student Loans (excl Veterans)
- ☐ 153 Recovery of Overpayment of Veteran's Benefits
- ☐ 160 Stockholder's Suits
- ☐ 190 Other Contract
- ☐ 195 Contract Product Liability

REAL PROPERTY
- ☐ 210 Land Condemnation
- ☐ 220 Foreclosure
- ☐ 230 Rent Lease & Eject
- ☐ 240 Torts to Land
- ☐ 245 Tort Product Liability
- ☐ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ☐ 310 Airplane
- ☐ 315 Airplane Product Liability
- ☐ 320 Assault, Libel & Slander
- ☐ 330 Federal Employers' Liability
- ☐ 340 Marine
- ☐ 345 Marine Product Liability
- ☐ 350 Motor Vehicle
- ☐ 355 Motor Vehicle Product Liability
- ☐ 360 Other Personal Injury

CIVIL RIGHTS
- ☐ 441 Voting
- ☐ 442 Employment
- ☐ 443 Housing/ Accommodations
- ☐ 444 Welfare
- ☐ 440 Other Civil Rights

PERSONAL INJURY
- ☐ 362 Personal Injury - Med. Malpractice
- ☐ 365 Personal Injury - Product Liability
- ☐ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ☐ 370 Other Fraud
- ☐ 371 Truth In Lending
- ☐ 380 Other Personal Property Damage
- ☐ 385 Property Damage Product Liability

PRISONER PETITIONS
- ☐ 510 Motions to Vacate Sentence
- Habeas Corpus:
- ☐ 530 General
- ☐ 535 Death Penalty
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition

FORFEITURE/PENALTY
- ☐ 610 Agriculture
- ☐ 620 Other Food & Drug
- ☐ 625 Drug Related Seizure of Property 21 USC 881
- ☐ 630 Liquor Laws
- ☐ 640 R R. & Truck
- ☐ 650 Airline Regs.
- ☐ 660 Occupational Safety/Health
- ☐ 690 Other

LABOR
- ☐ 710 Fair Labor Standards Act
- ☐ 720 Labor/Mgmt Relations
- ☐ 730 Labor/Mgmt. Reporting & Disclosure Act
- ☐ 740 Railway Labor Act
- ☐ 790 Other Labor Litigation
- ☐ 791 Empl Ret Inc Security Act

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ☐ 820 Copyrights
- ☒ 830 Patent
- ☐ 840 Trademark

SOCIAL SECURITY
- ☐ 861 HIA (1395ff)
- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

FEDERAL TAX SUITS
- ☐ 870 Taxes (U.S. Plaintiff or Defendant)
- ☐ 871 IRS - Third Party 26 USC 7609

OTHER STATUTES

VI. CAUSE OF ACTION (CITE THE U S CIVIL STATUTE UNDER WHICH YOU ARE FILING AND WRITE A BRIEF STATEMENT OF CAUSE DO NOT CITE JURISDICTIONAL STATUTES UNLESS DIVE
Action for patent infringement under 35 U.S.C. §271

VII REQUESTED IN COMPLAINT: CHECK IF THIS IS A CLASS ACTION ☐ Under F.R.C.P. 23 DEMAND $ CHECK YES only if demanded in complaint: JURY DEMAND: X YES __ NO

VIII. RELATED CASE(S) (See instructions): IF ANY Judge _____ Docket Number

DATE SIGNATURE OF ATTORNEY OF RECORD

February 17, 2006

Frederick L. Cottrell III

FOR OFFICE USE ONLY
RECEIPT #_____ AMOUNT ____ APPLYING IFP_____ JUDGE _____ MAG JUDGE _____

INSTRUCTIONS FOR ATTORNEYS COMPLETING CIVIL COVER SHEET FORM JS-44
Authority For Civil Cover Sheet

The JS-44 civil cover sheet and the information contained herein neither replaces nor supplements the filings and service of pleading or other papers as required by law, except as provided by local rules of court This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk

of Court for the purpose of initiating the civil docket sheet Consequently a civil cover sheet is submitted to the Clerk of Court for each civil complaint filed The attorney filing a case should complete the form as follows:

I (a) **Plaintiffs - Defendants**. Enter names (last, first, middle initial) of plaintiff and defendant If the plaintiff or defendant is a government agency, use only the full name or standard abbreviations If the plaintiff or defendant is an official within a government agency, identify first the agency and then the official, giving both name and title

(b) County of Residence For each civil case filed, except U S plaintiff cases, enter the name of the county where the first listed plaintiff resides at the time of filing In U S plaintiff cases, enter the name of the county in which the first listed defendant resides at the time of filing (NOTE: In land condemnation cases, the county of residence of the "defendant" is the location of the tract of land involved)

(c) Attorneys Enter firm name, address, telephone number, and attorney of record If there are several attorneys, list them on an attachment, noting in this section "(see attachment)"

II. **Jurisdiction**. The basis of jurisdiction is set forth under Rule 8 (a), F R C P , which requires that jurisdictions be shown in pleadings Place an "X" in one of the boxes If there is more than one basis of jurisdiction, precedence is given in the order shown below

United States plaintiff (1) Jurisdiction is based on 28 U S C 1345 and 1348 Suits by agencies and officers of the United States are included here

United States defendant (2) When the plaintiff is suing the United States, its officers or agencies, place an X in this box

Federal question (3) This refers to suits under 28 U S C 1331, where jurisdiction arises under the Constitution of the United States, an amendment to the Constitution, an act of Congress or a treaty of the United States In cases where the U S is a party the U S plaintiff or defendant code takes precedence, and box 1 or 2 should be marked

Diversity of citizenship (4) This refers to suits under 28 U S C 1332, where parties are citizens of different states When Box 4 is checked, the citizenship of the different parties must be checked (See Section III below; federal question actions take precedence over diversity cases)

III. **Residence (citizenship) of Principal Parties**. This section of the JS-44 is to be completed if diversity of citizenship was indicated above Mark this section for each principal party

IV. **Cause of Action**. Report the civil statute directly related to the cause of action and give a brief description of the cause

V. **Nature of Suit**. Place an "X" in the appropriate box If the nature of suit cannot be determined, be sure the cause of action, in Section IV above, is sufficient to enable the deputy clerk or the statistical clerks in the Administrative Office to determine the nature of suit If the cause fits more than one nature of suit, select the most definitive

VI. **Origin**. Place an "X" in one of the seven boxes

Original Proceedings (1) Cases which originate in the United States district courts

Removed from State Court. (2) Proceedings initiated in state courts may be removed to the district courts under Title 28 U S C , Section 1441 When the petition for removal is granted, check this box

Remanded from Appellate Court (3) Check this box for cases remanded to the district court for further action Use the date of remand as the filing date

Reinstated or Reopened (4) Check this box for cases reinstated or reopened in the district court Use the reopening date as the filing date

Transferred from Another District (5) For cases transferred under Title 28 U S C Section 1404(a) Do not use this for within district transfers or multidistrict litigation transfers

Multidistrict Litigation (6) Check this box when a multidistrict case is transferred into the district under authority of Title 28 U S C Section 1407 When this box is checked, do not check (5) above

Appeal to District Judge from Magistrate Judgment (7) Check this box for an appeal from a magistrate's decision

VII. **Requested in Complaint** Class Action Place an "X" in this box if you are filing a class action under Rule 23, F R C P

Demand In this space enter the dollar amount (in thousands of dollars) being demanded or indicate other demand such as a preliminary injunction

Jury Demand Check the appropriate box to indicate whether or not a jury is being demanded

VIII. **Related Cases** This section of the JS-44 is used to reference relating pending cases if any If there are related pending cases, insert the docket numbers and the corresponding judge names for such cases

Date and Attorney Signature. Date and sign the civil cover sheet
(rev 07/89)

AO FORM 85 RECEIPT (REV. 9/04)

United States District Court for the District of Delaware

Civil Action No. 06 105

ACKNOWLEDGMENT OF RECEIPT FOR AO FORM 85

NOTICE OF AVAILABILITY OF A UNITED STATES MAGISTRATE JUDGE TO EXERCISE JURISDICTION

I HEREBY ACKNOWLEDGE RECEIPT OF 1 COPIES OF AO FORM 85.

FEB 17 2006
(Date forms issued)

(Signature of Party or their Representative)

Gregory Stuhlman
(Printed name of Party or their Representative)

Note: Completed receipt will be filed in the Civil Action